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PROFESSIONAL PAPERS.

NEW SERIES.

LONDON:
GEORGE WOODFALL AND SON,
ANGEL COURT, SKINNER STREET.

J. M. Gordon
Capt. R. Engin

PAPERS

ON SUBJECTS CONNECTED WITH

THE DUTIES

OF THE

CORPS OF ROYAL ENGINEERS.

CONTRIBUTED BY MEMBERS OF THE ROYAL AND EAST INDIA
COMPANY'S ENGINEERS,

AND

EDITED BY A COMMITTEE OF ROYAL ENGINEERS.

VOL. II. NEW SERIES.

LONDON:
JOHN WEALE, 59, HIGH HOLBORN.

1852.

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NOTICE.

The Editors have to apologize to several Contributors for the non-insertion of their Papers, but the state of the funds at their command did not permit an extension of the volume.

G. G. LEWIS,
Major-General.

J. WILLIAMS,
Capt. R.E.

R. M. A., Woolwich,
December 29, 1851.

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PROFESSIONAL PAPERS.

PAPER I.

ON QUARRYING ROCK FOR GREAT WORKS, as practised at HOLYHEAD in the Years 1850 and 1851. By Major-General Sir JOHN F. BURGOYNE, I.G.F., and Lieutenant HUTCHINSON, R.E.

THE principal operation in the construction of the New Harbour of Holyhead consisted in throwing out a pier of stone 5000 feet in length, by a very large section in water, averaging 45 feet in depth.

Extensive quarry ground was obtained at a distance of 2330 yards from the harbour, and at an elevation of 90 feet above the sea; and a tram-road, at a moderate inclination, afforded every convenience for the carriage of the material.

The rock was a quartose schist, extremely hard, stratified in lines from N.E. to S.W., nearly vertical, or a little overhanging to the S.E., with occasional cracks or joints in that and other directions.

The chief engineer of the work appointed by the Admiralty was James Rendell, Esq.; and the contractors, Messrs. Rigby, of London.

In the autumn of 1850 the contractors, finding it too difficult to supply the quantity of material demanded by the engineer, namely, an average of 2500 to 3000 tons per day, by the ordinary process of blasting, even on the largest scale, which was also found to be very costly, exceeding what ought to afford a reasonable profit on the contract price, in concert with the engineer, were desirous of trying the effect of bringing down the rock by much larger explosions, to be carried out by means of shafts and galleries and chambers, instead of holes bored; in short, by *mines* in contradistinction to *blasts*.

In order to arrive as early as possible at the best system, they made application to the Master-General and Board of Ordnance for the presence, for a short period, of an officer of military engineers, to co-operate and advise with their own officers; and Captain George R. Hutchinson was selected for the duty, on account of much previous experience in effecting large explosions with gunpowder.

In this service he lost his life; and as a most valuable officer, it is impossible to allow the occasion to pass without introducing a few words in his praise.

Captain Hutchinson obtained his first commission as a Second Lieutenant on 29th May, 1832, and served successively at Chatham, Woolwich, the Mauritius, Devonport, Dover, Spithead, Brecon, and Gibraltar, to the entire satisfaction of his respective Commanding Officers.

In April, 1842, he was among the officers employed under the present Major-General Sir Charles Pasley, in the blowing-up of the *Royal George* at Spithead, a delicate and arduous undertaking, in which he was conspicuous for his zeal and intelligence; and in December, 1842, and January, 1843, while stationed at Dover, he was allowed by the Master-General to take the charge of blowing down a point of the high cliff near that place, under the chief direction of William Cubitt, Esq., C.E., for the line of railway there constructing under that engineer.

The operation was most successfully carried out, and the details, as described by Captain Hutchinson, will be found in the Professional Papers of the Corps of Royal Engineers, No. VI.

After serving for a year and a half at Brecon, he was stationed at Gibraltar from 1845 to September, 1850, where he again had an opportunity of directing and witnessing a great deal of rock-blasting.

It was impossible, therefore, to select an officer better qualified to assist the contractors at the Holyhead Works in their object.

In this duty he was zealously engaged from 24th October, 1850, until 24th February, 1851.

On that day he attended to witness the explosion of a considerable mine, the line of least resistance being 34 feet, and charge 2600 lbs. of powder.

The mass of spectators were placed in a situation that might reasonably be considered perfectly secure; he was among them, and if anything rather in the rear. The explosion took place; a shower of stones was thrown up to some distance around, from an unanticipated action of the mine, and he fell, struck down by one or more large masses, causing severe internal injury and comminuted fractures of the bones of his right thigh, knee, and leg. He died within eight hours of the accident, bearing himself, till he became unconscious, with the fortitude of a Christian and a soldier.

Thus fell, in the prime of life, a most valuable officer, under many of the circumstances, but without the éclat, of being killed on actual service.

Captain Hutchinson was most precise in the execution of all his duties: among his papers were found minute records of all the mining operations carried on during the period he was at Holyhead, made up to the time of his death.

These papers were put into the hands of his brother, Lieutenant C. S. Hutchinson, Royal Engineers, who from them, added to his own researches (having visited Holyhead for the purpose), has drawn up the following report of those operations.

J. F. B.

Report of Lieutenant C. S. Hutchinson, Royal Engineer, to the Inspector-General of Fortifications, respecting the Mining Operations at Holyhead Quarries.

Holyhead, August 1, 1851.

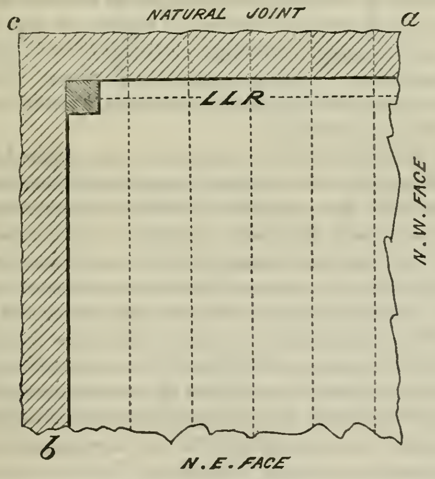
The accompanying rough plan and sections of the ground occupied by and available for the quarries, will show their outline at the present date, and also what it was, before the explosion of any mines, in November last. The position (as nearly as I could ascertain it) of each mine that has been fired, numbering the same in the order of explosion, has been marked on the plan, as also the galleries and shafts at present in progress, or ready for firing.

It will be observed that the outline of the quarries now presents several highly favourable positions for mines, many long faces being opened towards the N.W. (along the strike of the strata, the dip being nearly vertical, or overhanging towards the S.E., at an angle of from 80° to 85°); and the great object now sought is so to locate each mine that its explosion may tend to preserve and lengthen these N.W. faces, against which it has been found from experience that powder acts with a far greater effect than against any other.

The system now pursued and proposed for obtaining the greatest results at the smallest expense, is—

1st. To fix the position of the charge with reference to the natural fissures or joints which show themselves at irregular intervals both along the N.E. and N.W. faces of the rock (joints of stratification or cleavage), so that it may be a little in advance of the re-entering angle formed by such fissures or joints; to place it also so that the line of least resistance may be across the strata, and to arrange its vertical position in order that it may be 2 or 3 feet under the level of the floor of the quarry; this latter with a view to breaking-up as much as possible the bottom of the crater, whereby the great after expense of removing it by jumper-holes is saved.

2nd. To arrive at the position of the mine, in every practicable case, by entering the face by a gallery commenced as near the floor of the quarry as circumstances admit of, by carrying in this gallery to about the required vertical position of the charge, by sinking a shaft to gain its actual position below the level of the floor of the quarry, and then to form the chamber at right angles to the shaft. (The contractors' agent considers it preferable, where practicable to drive the gallery from (*a*) rather than (*b*), though the latter is a much easier operation, as the effect of the explosion generally, he thinks, tends to open first the joint *b c*, and so, if the gallery is along it, to release the tamping, and give greater facility of exit to the explosive gas, whereas, in explosion, the joint *a c* is somewhat at first compressed; and if, therefore, the gallery has been formed along it, the resistance of the tamping would be increased.)



3rd. To load the mine with a charge varying according to circumstances, which will be hereafter explained; to tamp it with rammed clay, and to fire it by the voltaic battery.

The system is also now usually adopted of removing the earth and loose rock from the top of the quarry over a mine intended to be fired, by sinking small shafts to the depth of about 20 feet, loading them with $\frac{1}{32}$ L.L.R.^{3} in feet for lbs. of powder, and firing them some days previous to the explosion of the mine. This is necessary, owing to its having been found that the earth, &c., where not removed, formed a conglomerate with much of the débris of the mine, and rendered the removal of the stone a more difficult operation.

It will be seen, on reference to the plan, that a number of galleries and shafts are now in progress. By commencing new ones after each explosion, following the principles above stated in the choice of position and mode of execution, it is anticipated that a constant and ample supply of stone will be kept up, increasing in quantity and decreasing in expense, as the height of face of the quarry becomes greater.

With reference to the system that is now considered the best for regulating and applying charges, the particulars of the excavation of galleries and shafts, loading, tamping, and firing:

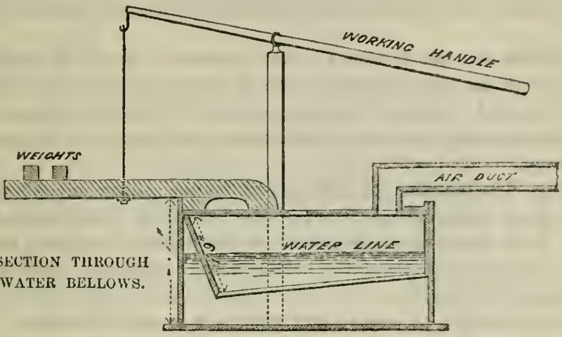
The system for regulating and applying charges has been already explained.

The particulars of the excavations of shafts and galleries are as follows:—

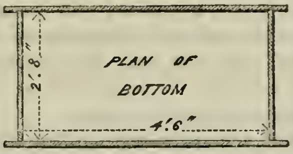
Shafts.—The average dimensions of the shafts are about 6 feet by 4 feet. In sinking them, the first object sought is to find a natural joint or fissure, and to make it form one side of the shaft, since holes driven sideways up to a joint will produce a much greater effect in explosion of the charges than if no such joint existed. It is therefore considered no object to depart a few feet from the wished-for horizontal position of a mine, to obtain the advantage of sinking along a joint, as the position can be regained by running a few feet of gallery when the shaft has reached its required depth.

The side next the joint is then first opened to its required breadth, and to about 18 inches in depth, by the explosion of charges lodged in $1\frac{1}{2}$-inch holes, driven down at 45° to meet the joint, and when a side has been thus opened, a few vertical holes are used to open the shaft to its full size. The holes are from 1 foot 6 inches to 2 feet deep, and are charged with 4, 6, or 8 oz. of powder, according to the effect required to be produced, and the appearance of the rock. These holes are driven by hand-jumpers, by two men, one turning and one striking, at the rate of from 5 to 6 feet lineal in the spell of 10 hours—a day's work. They are tamped with the soft stone and clay found in the joints of the rock, (the stone being first broken fine by the hammer), and the charges fired by Bickford's fuze. It may be assumed that 4 lbs. of powder are ordinarily consumed in removing 1 cubic yard of rock. The fragments of the explosion are generally broken up very small, and passed up the shaft in buckets. The rate of sinking the shafts necessarily varies much, depending on the degree of hardness, &c., of the rock passed through. As an average, it may be assumed that two parties of two men each, relieving each other day and night (equal to two men working for twenty hours), will sink about 1 foot in the twenty-four hours.

Galleries.—The dimensions of the galleries are from 3 feet to 4 feet wide, and from 5 feet to 5 feet 6 inches high. In commencing them, for the same reasons as in the shafts, a natural joint or fissure is always sought for, to form one side of the gallery. This side is generally opened to about 18 inches in depth, by holes driven horizontally, or with a slight inclination downward, and forming angles of 45° with the joint, the bottom of the side being first opened; the opening thus made gives a face for the more effective removal of the other side, which is done by the explosion of another series of holes. The holes are of the same dimensions, and loaded with the same charges as in the shafts, and they are driven at about the same rate. The débris is wheeled out in barrows.



SECTION THROUGH WATER BELLOWS.



The rate of driving the galleries varies very considerably with the nature of the rocks and direction of the strata. Under the most favourable circumstances, working with the strata, two parties of two men each, relieving each other day and night (working, that is 20 hours excluding meals), have driven 1 foot 8 inches per day; and in unfavourable cases with the strata, 1 foot 2 inches per day (of 20 hours). Against the strata, the rate per day of 20 hours has been as low as 6 inches to 8 inches, and has seldom exceeded 1 foot 3 inches per day in the most favourable circumstances. The ventilation of the shafts and galleries is a point that receives but little attention. Common and water bellows are occasionally used in the shafts, the air-ducts being formed with pitched canvas, and some shafts have attached to them a wooden framework on the principle of a windsail, which supplies a considerable quantity of air when any wind is blowing.

The excavations are principally performed by task-work; the workmen provide their own powder, fuze, and candles, which induces economy in their expenditure. The supply and repair of tools, and any casing or gear required, are supplied by the contractor.

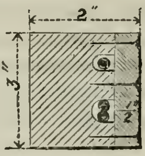
Loading.—The powder is brought in 50-lb. barrels (covered with sacks) to the mouth of the shaft, or gallery, on men's shoulders. They are there unheaded with a wooden mallet, and emptied into canvas bags holding 100 lbs. in the shaft mines, and 50 lbs. in the gallery mines, and passed down or along the shafts or galleries, as the case may be, no lights being used. The powder-box (or boxes if one would be too large to be got into the chamber), made of 1½-inch deal, ledged, having been previously firmly fixed in its position in the chamber, the powder is poured into it, the bursting charge being placed about the centre, and the wires led up through the lid of the box, which is then nailed on with copper nails. In wet weather the box would be made of 1½-inch deal, ploughed and tongued, and covered with painted cloth at the bottom; the lid would have a rise to the centre, and the whole would be coated with a composition of pitch and tallow.

If more than one box is used a communication is formed between them by passing through the adjacent sides of each a wooden tube entering a few inches into each box, and becoming filled with powder as the loading advances.

The loading occupies from one to three hours, according to the size and position of the charge.

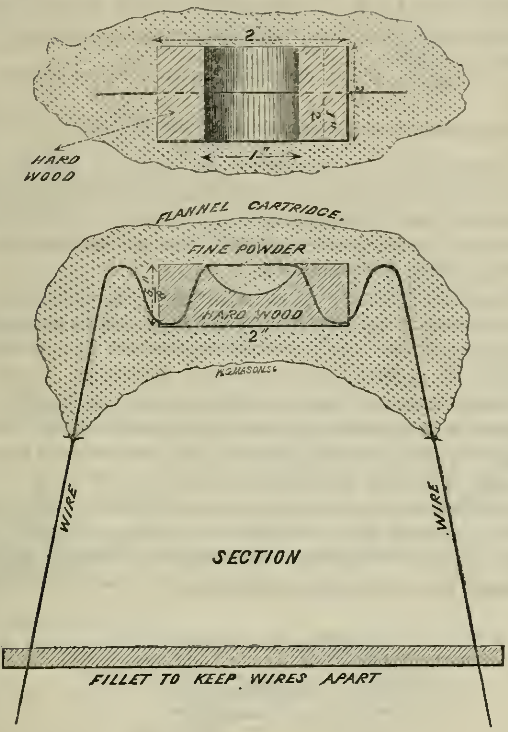
Tamping.—The tamping now always used for the gallery mines is a red clay, of which great quantities are found in the immediate neighbourhood of the quarries. It is conveyed to the mouth of the gallery in waggons, and carried along it in bags, on men's shoulders, holding about 1 cwt. each. Next the charge, and for about 10 feet in front of it, it is rammed at about every 6 inches; for the next 10 feet at every 12 inches; and after this at every 18 inches. The rate varies, of course, with the nature of the excavation, but will average about 3 feet per hour for each operation, from sixteen to twenty men being constantly employed. This, of course, does not include the transport of the clay from the bank to the mouth of the gallery. The shafts are generally tamped with the earth, and loose stone, met with near their commencement, thrown in and rammed at irregular intervals. It is executed at an average rate of 10 feet per hour by from eighteen to twenty-two men.

Firing.—The mode of communicating ignition to the charge is almost universally by the galvanic battery. That used is of the form invented by Mr. Grove, consisting of eight cells, contained in a box measuring 1 foot 9 inches × 1 foot 3 inches × 1 foot, the electric current being generated by alternate plates of platina foil and zinc immersed in nitric and dilute sulphuric acid. Communication is established with the charge by means of two copper wires, No. 12 guage. From the battery to the mouth of the shaft or gallery they are covered with gutta percha. In the first straight branch of the shaft or gallery the wires (without gutta percha) are separated and secured in a piece of scantling with two grooves in it (in one groove Bickford's fuze is also placed, as a reserve, in case of accident to the wires); over the grooves is then nailed a slip of deal, and the scantling placed in one angle of the shaft or gallery. After the termination of the scantling the



SCANTLING FOR WIRES.

wires are first separately bound round with old calico and sacking, and then bound together, the fuze with them, conducted up to the chamber and connected



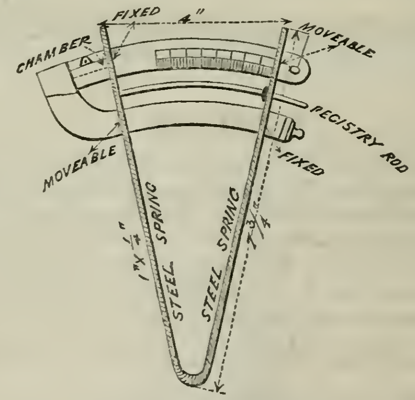
BURSTING CHARGE.

with the bursting charge, the most secure and convenient form of which is shown in the sketch given above. The battery is usually placed in a rude hut on the top of, and from 200 to 300 feet from, the face of the quarries.

As to the "quantity and quality of powder used under different circumstances, and whether, if the powder is of a superior quality, the contractors have any means of testing it, or take it on credit from the manufacturers," by reference to the table accompanying this report, mines Nos. 43 and 30, it will be seen that the charges have varied from $\frac{L L R^3}{3}$ in lbs. of powder, as a maximum to $\frac{L L R^3}{39}$ as a minimum. The first of these was, however, much in excess, and the latter fired for the purpose of overturning a mass of rock very much cracked and shaken, and very favourably situated for dislodgement. In the commencement of the mining operations the charges were used too low, and experience has shown the necessity of greatly increasing them, with a view principally to the more effectual breaking up of the bottom of the crater, to do which the charge has had to be lodged on a lower level, and consequently increased in magnitude, and enabled to overcome the additional resistance offered to it.

Considering the level of the charge as constant, the main element in estimating its size would appear to be whether it has to operate against a N.W. face, a N.E. face, or a S.E. face. Classifying the charges fired under these heads, we have them varying with the L.L.R. against the strata, and to operate against a N.W. face (when lodged level with, or 2 to 3 feet above or below, the floor of the quarry), from $\frac{\text{L L R}^3}{10}$ to $\frac{\text{L L R}^3}{26}$, giving, out of seventeen fired, an average charge of $\frac{\text{L L R}^3}{17}$, with a produce of material in tons varying from $4\frac{2}{3}$ to 0 per lb. of powder, or an average of $3\frac{1}{12}$ tons per lb. In mines fired with the L.L.R., with the strata, and to operate against a N.E. face, with the charges on the same level as above, out of six fired the charges varied from $\frac{1}{6}$ to $\frac{1}{22}$ L.L.R.^{3}, with an average of $\frac{1}{14}$ L.L.R.^{3}, and a produce of materials in tons varying from 3 to 0 per lb. of powder, and an average of $1\frac{1}{2}$ ton per lb.

In these three mines (Nos. 31, 43, and 56), with the L.L.R. against the strata, and to operate against a S.E. face, Nos. 31 and 43 were more or less failures with charges of $\frac{1}{3}$ and $\frac{1}{25}$ L.L.R.^{3}. In No. 56, with a charge of $\frac{2}{7}$ L.L.R.^{3}, the explosion was very violent, the probable produce about $2\frac{3}{4}$ tons per lb. In all the mines but three, common merchant's blasting powder was used. In Nos. 39, 51, and 52, a stronger powder, in the proportion of twenty to seventeen of the other, was employed, though the charges do not appear to have been reduced in consequence. The only means of testing the strength of the powder is by a small hand éprouvette, in which, however, the chamber and priming-hole are so small that it is necessary to pulverize the powder before exploding it, thereby probably invalidating the accuracy of the tests. The respective strengths indicated by the éprouvette nearly agreed with those furnished by the powder merchants.



SKETCH OF EPROUVETTE.

The prices of ingredients and rates for work performed are, as far as could be ascertained, as follows:—

	Maximum rate.	Minimum rate.	Average rate.
	s. *d.*	*s.* *d.*	*s.* *d.*
Shafts (by task-work, the workmen finding their own powder, fuze, and candles), for the first 20 feet deep, per foot running . .	14 0	6 8	9 1½

	Maximum rate.		Minimum rate.		Average rate.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*
For the next 25 feet, per foot running	26	8	13	4	18	0
For the next 25 feet, per foot running	27	6	18	4	22	11
A depth of 45 feet or over, let out at an uniform rate per foot running	20	0	16	0	18	2
Galleries (by task-work, as before,) various lengths per foot running	20	0	8	4	15	6
Tamping shafts with earth and stones rammed (day work), per foot running	1	1	0	7	1	0
Tamping galleries with rammed clay (day work) (clay deposited at mouth of gallery), per foot running	2	0	0	9	1	3

		£	*s.*	*d.*
Common blasting powder,	per lb. on the works	0	0	6
„ „ „	per ton at the manufactory	40	0	0
Superior „ „	per lb. on the works	0	0	7¾
„ „ „	per ton at the manufactory	52	0	0
Bickford's fuze	per coil of 25 feet, on the works	0	0	3½
No. 12 copper wire, coated with gutta percha	per yard, at the manufactory	0	0	6
Best steel	per ton, at the manufactory	66	0	0
Sharpening, steeling, and leading drills, labour only	per foot running of shaft or gallery	0	1	0
Finding coals, steel, iron, carriage of jumper to and from forge, casing and gear of shafts and galleries	do. do.	0	1	6
Quarrymen's wages	per day of ten hours	0	2	1

With regard to "the great results obtained on the present system explanatory of the expenditure in time, labour, gunpowder, &c., &c., to produce in the quarries any given amount of cubic yards, or tons of material, in a fit state for the breakwater," the most correct data will be obtained by taking the average of the successful operations against a N.W. and N.E. face respectively. Against a N.W. face, supposing an average height of quarry of 100 feet, and the charge lodged near the level of the floor, 9100 tons of material in a fit state for the breakwater have been procured from gallery mines in the time necessary to form and load and tamp 47½ feet of gallery and 18½ feet of shaft, consuming 64 working days, or nearly eleven weeks (the men working day and night); the expenditure of powder was 1830 lbs., or 5 tons per lb. of powder, and the expense £125, or about 3¼*d.* per ton, the above being an average of nine explosions. Against a N.E. face, taking the average of four successful explosions from gallery mines, with a height of face varying from 40 feet to 80 feet, and the charge lodged as before, 4600 tons of material in a fit state for the breakwater were dislodged in the time taken to form, load, and tamp 54 feet of gallery and 17 feet of shaft, consuming 68 working days, or 11⅓ weeks (the men working day and night), with a charge of 2165 lbs. of powder, or 2⅐ tons per lb., and an expense of £115 11*s*., or 6*d*. per ton. Height of face necessarily constitutes a very main element in the yield of the mines, and this will be constantly improving as the face of the mountain is exposed to the S.W.

Shaft mines, with any large height of face, are far more expensive than gallery mines, and are now never used except in cases of emergency, or for the reason before described.

Some few details respecting the tools, &c., used in the quarrying operations may be useful.

Various forms of jumper heads have been tried, and that found to answer best has been a chisel head, with the edge slightly curved. The sizes of the chisels vary with the depth of the holes to be sunk.

For a hole not exceeding		3 feet deep	. . . .	chisel 1½	inch.
„	„	6 „	. . . .	„ 2	„
„	„	10 „	. . . .	„ 3	„
„	„	15 „	. . . .	„ 3½	„

In the rock of ordinary hardness about sixty drills are required to sink 4 feet.

Skilful smiths can sharpen about fifteen 3-inch jumpers in the hour. The weight of hammer for drills are—

1½-inch drill	. . . .	8-lbs.	hammer.
2 „	. . . .	10	„
3 „	. . . .	10 to 11	„
3½ „	. . . .	12	„

1½-inch holes are driven 6 feet, by two men, in about 10 hours, or $\frac{6}{10}$ foot per hour; 3-inch holes, 3 feet to 4 feet, in 10 hours, by three men, two striking and one turning, or $\frac{3}{10}$ foot to $\frac{4}{10}$ foot per hour; 3½-inch holes, 2 feet 6 inches per 10 hours, or ¼ foot per hour, by three men the first 10 feet, and afterwards by four, two to turn and two to strike.

I inclose rough sketches of all the operations of which I was able to obtain the requisite information.

C. S. HUTCHINSON,
Lieut. R.E.

OBSERVATIONS by Major-General Sir J. BURGOYNE, on Lieutenant HUTCHINSON'S REPORT on HOLYHEAD QUARRIES, of August 1, 1851.

	EXPLANATIONS.
The direction of the strata is not quite clearly defined. It is stated "many long faces have been opened towards the N.W. along the strike of the strata, the dip being nearly vertical, or overhanging towards the S.E., at an angle of from 80° to 85°." Is, then, the direction of the line of strata N.E. and S.W. of these faces towards the N.W.? I can only perceive that of No. 9 Quarry.	The general direction of the line of strata is N.E. and S.W., and the most favourable face for operating upon is therefore one facing the N.W. The "many long faces towards the N.W." alluded to, were, besides that in No. 9 Quarry, those varying from 50 to 100 feet in length, occurring at intervals along the general line of the quarries.
It would appear to me that by cutting through from No. 7 and No. 8 Quarries, into and to the end of No. 9 Quarry, on a face of 107 feet, there would eventually be a face of 163 feet obtained, which would gradually increase to 340 feet, and all facing the most favourable point N.W.	I believe the contractors have some such intention, but unless they stop operations in No. 9 Quarry until Nos. 7 and 8 are carried into it, it will be a very long time before the advantage of a greatly increased height of face is gained, as the face of No. 9 will be receding towards the S.E. very much faster than the faces of Nos. 7 and 8 can be carried in to the S.W.
In sinking the shafts by jumper holes 1½ inch, and from 1 foot 6 inches to 2 feet deep, two men are employed, "one turning and one striking." Have they tried the churn jumpers worked by hand, and not hammered, and why do not they use them?	Not having entered into this question when at Holyhead, I have written to the contractor's agent for information, and have not yet received his reply.
Is the clay used for the tamping, and brought to the galleries for the purpose, in a moist or dry state?	In a somewhat moist state, and is tough and adhesive.
MAJOR-GEN. SIR J. BURGOYNE.	C. S. HUTCHINSON, Lieut. R.E. *Spike Island, August* 25, 1851.

DETAILS OF THE SEVERAL MINES THAT HAVE BEEN

FROM THEIR COMMENCEMENT UP

Number of operation.	Date of explosion.	Number of quarry.	Depth of shaft.	Length of gallery.	Vertical height from chamber to top of rock to be removed.	Level of floor of chamber with reference to floor of quarry.	Line of least resistance.	Description of powder used.	Charge in pounds.	Proportion of charge to the cube of the line of least resistance.
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.			
1	1850. Nov. 1	8	29 6	......	29 6	70 6 above	24 0	Common merchant's powder.	432	$\frac{1}{32}$
2	Nov. 13	3	41 0	......	41 0	54 0 above	27 0	Do.	600	$\frac{1}{32}$
3	Nov. 30	1	48 6	......	48 6	2 0 above	36 0	Do.	1700	$\frac{1}{27}$
4	Dec. 7	5	64 0	......	64 0	26 0 above	30 0	Do.	1700	$\frac{1}{25}$
5	Dec. 21	3	74 6	9 0	74 0	17 0 above	41 0	Do.	2800	$\frac{1}{25}$
6	Dec. 21	6	68 0	18 0	78 0	15 0 above	39 0	Do.	2300	$\frac{1}{26}$
7	Dec. 21	4	5 0	34 0	100 0	10 0 above	32 0	Do.	1400	$\frac{1}{23}$
8	1851. Jan. 4	5	62 0	......	64 0	36 0 above	31 0	Do.	1200	$\frac{1}{25}$
9	Jan. 11	6	80 0	7 6	80 0	10 0 above	31 0	Do.	1200	$\frac{1}{25}$
10	Jan. 16	9	......	47 0	40 0	3 0 above	24 0	Do.	530	$\frac{1}{26}$

FIRED IN THE HOLYHEAD BREAKWATER QUARRIES,

TO THE 31ST OF JULY, 1851.

Nature of tamping.	Mode of effecting ignition.	Probable quantity of material procured, in tons.	Quantity of material to each pound of powder, in tons.	Total expense of operation.			Cost of each ton of material.		Remarks.
				£	s.	d.	s.	d.	
Loose stone and earth rammed.	Voltaic battery.	3320	7½	54	12	4	0	4	Effect satisfactory. Explosion not violent. A better result would have been produced by sinking the shaft to a lower level, so as to give a larger mass to be operated on. L.L.R. against the strata of the rock.
Do.	Do.	3600	6	57	8	0	0	4	Explosion quiet. Piece of rock left standing on west of chamber, owing to a loose joint intervening. L.L.R. against the strata.
Do.	Do.	10,000	6	125	0	0	0	3	Explosion not violent. Proportion of charge increased beyond the $\frac{1}{32}$, owing to confined position of rock to be removed. L.L.R. against the strata.
Do., and sand, rubble, masonry, and concrete for 3 ft. over-charge.	Do.	6500	3¾	100	0	0	0	3¾	Charge increased 100 lbs. by mistake, but explosion by no means violent in consequence. Mass well thrown out for loading. L.L.R. with the strata.
Dry rubble masonry in gallery, and rammed earth and stone in shaft.	Do.	16,000	5¾	174	6	6	0	2¾	This charge used on account of a confined position, for the purpose of throwing the mass well out, and breaking up the bottom of the quarry under the charge. Explosion easy. L.L.R. with the strata.
Do.	Do.	11,000	4¾	135	2	0	0	3	Position of mass to be removed more favourable than in the preceding, and charge therefore somewhat reduced. Explosion rather violent. L.L.R. against the strata, though the principal effect of the powder acted with them. Much of the bottom left standing.
Rubble masonry and rammed clay.	Do.	1000	¾	57	3	6	1	1½	Charge had been increased to the $\frac{1}{23}$, owing to confined position of mass, and to the L.L.R. being with the strata. The effect of the explosion was only to blow out the tamping, and throw down a portion of stone by concussion. Parts of the mass much cracked, and afterwards readily removed. Tamping must have been the weakest line; would have been better all of clay.
Loose earth and rammed stone.	Do.	6500	5½	105	13	7½	0	4	L.L.R. against the strata. Charge not found at all too great, explosion being gentle. It was found advisable to be in excess rather than deficiency with the powder, as much after expense is thereby avoided.
Do.	Do.	7000	5¾	135	8	0	0	4¾	L.L.R. against the strata. Explosion not violent. Stone well deposited for loading the waggons. A mass of rock near the top left standing, indicating that a more advantageous result would have been produced had L.L.R. been greater, and charge consequently larger.
6 ft. cement masonry, 6 ft. rubble masonry in mortar, timber buttress, rammed clay and stone.	Do.	1500	2¾	43	9	6	0	7	L.L.R. against the strata. Explosion gentle, but much stone not thrown down, though the mass operated on was so much cracked as to render its after removal easy. Force of the powder was probably somewhat lost through a loose fissure which happened to be near the chamber.

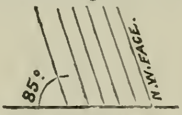
Number of operation.	Date of explosion.	Number of quarry.	Depth of shaft.	Length of gallery.	Vertical height from chamber to top of rock to be removed.	Level of floor of chamber with reference to floor of quarry.	Line of least resistance.	Description of powder used.	Charge in pounds.	Proportion of charge to the cube of the line of least resistance.
	1851.		ft. in.	ft. in.	ft. in.	ft. in.	ft. in.			
11	Jan. 17	4	7 0	39 0	92 0	8 0 above	32 0	Common merchant's powder.	1400	$\frac{1}{23}$
12	Jan. 18	7	11 0	44 0	85 0	5 0 above	33 0	Do.	1400	$\frac{1}{26}$
13	Feb. 7	4	15 0	46 0	100 0	Level	34 0	Do.	1800	$\frac{1}{22}$
14	Feb. 13	9	...	46 0	40 0	Level	25 0	Do.	1000	$\frac{1}{16}$
15	Feb. 18	3	75 0	...	75 0	17 0 above	37 0	Do.	2500	$\frac{1}{20}$
16	Feb. 20	8	67 0	22 0	73 0	Level	38 0	Do.	4000	$\frac{1}{14}$
17	Feb. 24	9	45 6	5 0	50 0	2 0 below	34 0	Do.	2600	$\frac{1}{15}$
17a	Feb. 25	9	56 6	5 0	60 0	4 0 above	33 0	Do.	2000	$\frac{1}{18}$

Nature of tamping.	Mode of effecting Ignition.	Probable quantity of material procured, in tons.	Quantity of material to each pound of powder, in tons.	Total expense of operation.	Cost of each ton of material.	Remarks.
				£ s. d.	s. d.	
6 ft. cement masonry, 6 ft. rubble masonry in mortar, timber buttress, rammed clay and stone, and additional timber buttress.	Voltaic battery.	Nil.	Nil.	Not recorded	...	This mine was a failure, the tamping having been blown out and no other effect produced; caused, probably, by line of tamping not having been long enough with reference to L.L.R., and also to the powder being injured by wet. L.L.R. against the strata.
Cement and mortar masonry, and rammed clay.	Do.	4850	3½	90 10 0	0 4½	Explosion gentle. L.L.R. against the strata. Charge probably too small, as a large mass of rock was left standing in the centre of that intended to have been removed. It was much shaken, and removed by charging the rents, &c.
Rammed clay and timber buttress.	Do.	8000	4½	120 18 0	0 3½	Explosion gentle. L.L.R. against the strata. The charge was increased to $\frac{1}{22}$ L.L.R.^{3}, owing to its having been found, on removal of the débris from many of the mines, that the bottoms of the craters were left uninjured. By increasing the charge, and placing it on a lower level, it was hoped to remedy this. The cost includes only the second operation (this being the same mine as No. 11, with new chamber). If to it be added the cost of the first failure, the expense would be increased to 5*d*. per ton.
Rammed clay.	Do.	4000	4	52 0 0	0 3	The position of this mine being very unfavourable, the charge was largely increased. The explosion not violent, and débris well deposited for loading. L.L.R. with the strata.
Rammed earth and stone.	Do.	2000	⅘	151 13 0	1 6	L.L.R. with the strata. Effect bad; very little stone thrown down, probably owing to the explosive gas meeting with an easy exit in some loose joints that occurred in the neighbourhood of the chamber.
Rammed clay, loose stones, and earth.	Do.	10,000	2½	190 5 4	0 4½	Experience having now clearly shown that the mines fired with the L.L.R. with the strata, had been considerably undercharged, with the exception of No. 14, where the height was small and rock soft, it was determined to increase the charge to $\frac{1}{14}$ L.L.R.^{3}. The effect was excellent. Explosion not violent, but débris admirably disposed for loading, and bottom of crater completely broken up. [Captain Hutchinson's notes terminate here, and the records of the following mines have been obtained from the Contractor's agent.]
Gravel and sand.	Do.	20,000	4⅛	237 15 0	0 2¾	These two mines, to act against a N. W. face of 165 ft. in length, were intended to have been fired simultaneously; but by some accident the wires of 17^a became disconnected, and 17 only exploded, and instead of acting on the whole mass in front of it, exerted its power on a small piece situated immediately over the charge, and isolated from the large mass by natural joints. This was blown up into the air, and fell broken into fragments in a circle of upwards of ⅓ mile radius; one piece striking and fatally injuring Capt. Hutchinson, R.E., who was standing at a distance of about 250 yards from the shaft.
Do.	Do.					

Number of operation.	Date of explosion.	Number of quarry.	Depth of shaft.	Length of gallery.	Vertical height from chamber to top of rock to be removed.	Level of floor of chamber with reference to floor of quarry.	Line of least resistance.	Description of powder used.	Charge in pounds.	Proportion of charge to the cube of the line of least resistance.
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.			
18	1851. March 1	1	43 0	6 0	45 0	2 0 above	40 0	Common merchant's blasting powder.	2500	$\frac{1}{26}$
19	March 15	2	24 0	69 0	40 0	2 0 below	30 0 26 0	Do.	2160 1600	$\frac{1}{12}$ $\frac{1}{11}$
20	March 19	5	12 0	52 0	78 0	2 0 below	36 0	Do.	3000	$\frac{1}{16}$
21	April 4	3	17 0	38 0	90 0	2 0 below	41 0	Do.	3200	$\frac{1}{22}$
22	April 5	9	7 0	37 0	45 0	Level	27 0	Do.	1400	$\frac{1}{14}$
23	April 5	10	30 0	4 0	30 0	2 0 below	24 0	Do.	700	$\frac{1}{20}$
24	April 15	8	81 6	12 0	81 6	6 0 below	32 0	Do.	2500	$\frac{1}{13}$
25	April 22	1	52 0	34 0	52 0	5 0 above	39 0 34 0	Do.	2200 2000	$\frac{1}{27}$ $\frac{1}{20}$

Nature of tamping.	Mode of effecting ignition.	Probable quantity of material procured, in tons.	Quantity of material to each pound of powder, in tons.	Total expense of operation.			Cost of each ton of material.		Remarks.
				£	s.	d.	s.	d.	
									The mass not blown down was much rent; 17^a was fired the next morning with good effect. The charge of 17 was made so much larger than 17^a owing to the greater mass on which it had to act, as will be seen on reference to the drawing. L.L.R. against strata.
Loose earth and stone.	Voltaic battery,	10,000	4	121	10	0	0	3	L.L.R. against strata. A portion of mass intended to have been removed above and behind the charge left standing, indicating too small a quantity of powder.
Rammed clay.	Do.	4500	1$\frac{1}{5}$	196	5	8	0	10	These two charges were fired simultaneously from either end of a T gallery, to make an opening in a face of rock, the L.L.R.s being with the strata; owing to which, and to the low level of the charges, they were of the large amount expressed. The effect was rather violent, stones being projected to some distance. No tendency to blow the tamping; the desired result was effected.
Do.	Do.	9000	3	133	5	9	0	3$\frac{1}{2}$	L.L.R. against strata. Natural joints interfered with the anticipated effect, and one opening near the gallery, a large portion of the tamping was blown out; part of the bottom of crater left standing.
Do.	Do.	9120	2$\frac{3}{4}$	132	10	0	0	3$\frac{1}{2}$	L.L.R. against the strata. Charge in a favourable position. A natural point just in front of the charge again interfered with the production of the anticipated effect, and a portion of the tamping was also blown; had which not occurred, the rock would probably have been better broken up.
Do.	Do.	3000	2$\frac{1}{7}$	67	19	0	0	5$\frac{1}{2}$	L.L.R. against the strata. Explosion not violent. Stone very well broken for loading. Cause of large increase to charge is not explained; the position appearing similar to that of the last mine. Charge does not appear to have been in excess.
Loose stone and earth rammed.	Do.	2000	2$\frac{6}{7}$	43	0	0	0	5	L.L.R. against strata. Explosion rather violent, indicating a somewhat excess of powder, as might have been anticipated, from the nearness of the charge to the surface, where the rock is generally of less tenacity than at lower levels.
Do.	Do.	4000	1$\frac{3}{5}$	170	0	0	0	10$\frac{1}{4}$	L.L.R. against the strata. Explosion not violent, but result unsatisfactory, owing to the occurrence of natural joints immediately in front of the charge, to which the rock was blown out, leaving the whole of the shaft, tamping, &c., uninjured. Cause of the large proportion of the charge to L.L.R.^{3} not explained; its low level would appear the only reason.
Earth and clay rammed.	Do.	12,500	3	211	9	1$\frac{1}{2}$	0	4	L.L.R. against strata. These mines were fired simultaneously against a face of 91 ft. long; owing to which cause and to the comparatively high level at which they were placed, the charges were reduced to the expressed propositions of L.L.R.^{3}. Owing to the comparative hardness of rock in front of 2000 lbs. charge, and to the mass being tightly bound by a clay fault, its proportion was increased over that of the other. The result was good, though the 2200 lbs. charge broke up the rock better than the other.

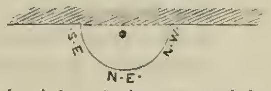
Number of operation.	Date of explosion.	Number of quarry.	Depth of shaft.	Length of gallery.	Vertical height from chamber to top of rock to be removed.	Level of floor of chamber with reference to floor of quarry.	Line of least resistance.	Description of powder used.	Charge in pounds.	Proportion of charge to the cube of the line of least resistance.
	1851.		ft. in.	ft. in.	ft. in.	ft. in.	ft. in.			
26	April 29	4	29 0	6 0	29 0	80 0 above	23 0	Common merchant's blasting powder.	800	$\frac{1}{15}$
27	May 3	3	12 6	39 6	90 0	1 6 above	35 0	Do.	2200	$\frac{1}{19}$
28 29	… …	…	… …	… …	… …	… …	… …	… …	… …	… …
30	May 10	9	… …	36 0	50 0	Level	33 0	Do.	900	$\frac{1}{39}$
31	May 13	2	19 6	49 0	88 0	2 6 below	35 0	Do.	2100	$\frac{1}{20}$
32	May 13	5	23 0	50 6	118 0	2 0 below	40 0	Do.	2600	$\frac{1}{25}$
33	May 20	Gullet.	55 0	12 0	55 0	5 0 above	38 0	Do.	2500	$\frac{1}{22}$
34	… …	2	Not recorded		… …	… …	… …	… …	… …	… …
35	May 21	4	19 0	51 0	100 0	2 0 below	38 0	Do.	3000	$\frac{1}{18}$
36	May 28	7	18 0	51 0	90 0	3 0 below	38 0	Do.	2100	$\frac{1}{26}$
37	May 28	…	Not recorded		… …	… …	… …	Do.	550	Not
38	May 30	10	Not recorded		… …	… …	… …	Do.	800 2100	Not

Nature of tamping.	Mode of effecting ignition.	Probable quantity of material procured, in tons.	Quantity of material to each pound of powder, in tons.	Total expense of operation.	Cost of each ton of material.	Remarks.
				£ s. d.	s. d.	
Loose stone and earth.	Voltaic battery.	3000	3¾	45 0 0	0 3½	L.L.R. against the strata. Explosion violent; stones thrown to a considerable distance. Charge in excess.
Rammed clay and gravel.	Do.	Nil.	Nil.	95 0 0	Nil.	L.L.R. with strata. Tamping blown out, and the angles removed from the shaft and gallery, as shown in sketch. The chamber was badly situated, and the charge probably too small, the rock to be acted on being very tightly bound.
... ...	... ...	... ...	... ...	... ...	...	Small top shafts, which answered well. Details not recorded.
Do.	Bickford's fuze.	3500	4	Not re	corded	L.L.R. with the strata. This extremely small charge was used, on account of the mass to be removed being greatly cracked, and a bed joint occurring at the floor of the quarry; the height of face also being small. It answered well. The wires had become injured in tamping, and fuze was therefore used.
Rammed clay.	Voltaic battery.	Nil	... ...	Not re	corded	L.L.R. against the strata. Though against a S.E. instead of N.W. face, the dip of the strata being thereby rendered less favourable for the dislodgment of the rock. The result was, that the rock was much shattered in a N.E. and S.W. direction; but not overturned. The tamping was blown. Charge too small.  SECTION SHOWING PLANES OF STRATA.
Do.	Do.	10,000	3$\frac{6}{7}$	Not re	corded	L.L.R. against the strata. Said to have worked well, and to have produced the anticipated result.
Earth and loose stones rammed.	Fuze.	Not re	corded.	Not re	corded	Stated to have produced a very good effect, but no details are furnished. Battery out of order.
... ...	... ...	... ...	... ...	... ...	... ...	Small top shaft, which answered well.
Rammed clay.	Voltaic battery.	12,000	4	Not re	corded	L.L.R. against strata. Effect remarkably good. Stone well broken, and conveniently deposited for loading.
Do. & fine stone.	Do.	9000	4⅓	Not re	corded	L.L.R. against strata. The face to be operated against being well open to the N.W., the only reason recorded for the great difference between this charge and the last, both having the same L.L.R.s. It is described to have answered well.
recorded.	... ...	... ...	Not	recorded	... ...	A small top shaft.
recorded.	Do.	Not	recorded	... ...	... ...	There is no sketch, and but a very imperfect record of this operation. The two charges were intended to have been fired simultaneously; but, owing to the weakness of iron and zinc plate battery, only one was ignited (the small one); and though

Number of operation.	Date of explosion.	Number of quarry.	Depth of shaft.	Length of gallery.	Vertical height from chamber to top of rock to be removed.	Level of floor of chamber with reference to floor of quarry.	Line of least resistance.	Description of powder used.	Charge in pounds.	Proportion of charge to the cube of the line of least resistance.
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.			
39	1851. June 3	4	23 0	39 0	90 0	Level	26 0	Stronger merchant's powder, as 20 to 17 of the other.	1700	$\frac{1}{10}$
40	June 7	3	22 0	60 0	60 0	2 0 below	36 0	Common merchant's blasting powder.	2100	$\frac{1}{22}$
41	June 14	4	Not re	corded	... ...	... ...	... ...	Do.	600	Not
42	June 20	5	14 0	59 0	55 0	2 0 below	40 0	Do.	3500	$\frac{1}{18}$
43	June 25	2	19 6	44 0	88 0	2 0 below	18 0	Do.	1900	$\frac{1}{3}$
44	June 30	Not	record	ed	... ...	... ...	... ...	Do.	850	Not
45	July 2	9	Not re	corded	... ...	... ...	... ...	Do.	2420	Not
46	July 5	Not	record	ed	... ...	... ...	... ...	Do.	600	Not
47	July 5	9	Not re	corded	... ...	... ...	... ...	Do.	2200	Not
48 49	July 7	Not	record	ed	... ...	... ...	... ...	... ...	... ...	... ...
50	July 11	4	23 0	40 0	82 0	3 0 below	22 0	Do.	1800	$\frac{1}{6}$
51	July 12	9	48 6	55 0	50 0	2 6 below	33 0	Stronger powder.	2300	$\frac{1}{15}$
							33 0	Mixed do. (common and stronger).	2700	$\frac{1}{13}$
52	July 12	9	57 0	48 0	57 0	2 6 below	38 0	Stronger powder.	3000	$\frac{1}{18}$

Nature of tamping.	Mode of effecting ignition.	Probable quantity of material procured, in tons.	Quantity of material to each pound of powder, in tons.	Total expense of operation.			Cost of each ton of material.		Remarks.
				£	s.	d.	s.	d.	
									the other was fired afterwards, the effect, owing to the non-simultaneity of explosion, was very poor.
Rammed clay.	Voltaic battery	8000	$4\frac{2}{3}$	Not recorded					L.L.R. against strata. Explosion not violent, and result very good. Gallery in this instance was driven against the stratification; considered a better plan where practicable, as the action of the explosion tends rather to bind than liberate the tamping. The charge appears very high, and would equal $\frac{1}{8}$ L.L.R.^{3}, by reducing the quantity of powder to its equivalent of the ordinary kind. No explanation for the increased charge afforded in the record.
Do.	Do.	5000	$2\frac{3}{5}$	110	0	0	0	$5\frac{1}{4}$	L.L.R. with the strata. The object of the mine was to open a N.W. face, which it did very effectually, breaking up and dispersing the stone to advantage. The charge appears very small, considering the position, &c.
recorded	... ...	... ...	... ...	...	...		...	...	A shallow top shaft, which answered well.
Rammed clay.	Do.	8000	$2\frac{2}{7}$	Not re-corded					L.L.R. against the strata. Explosion gentle; result as anticipated.
Do.	Do.	Not recorded		...	...		...	...	The same gallery as in No. 31, which had failed. The chamber was advanced nearer to the S.E. face, to obtain a more secure position for the charge, as the rock was much rent around its former site. A very high charge was put in, the effect of which was to overthrow violently the rock in the direction of L.L.R., but still leave the main mass standing. A smaller charge would have done better probably.
recorded	... ...	... ...	... ...	...	...		...	...	Small top shaft, which answered well.
recorded	... ...	... ...	... ...	...	...		...	...	No details or dimensions. Fired from a shaft, and answered well.
recorded	... ...	... ...	... ...	...	...		...	...	Small top shaft.
recorded	... ...	... ...	... ...	...	...		...	...	A gallery mine, whose effect was good. No sketch or details.
... ...	... ...	... ...	... ...	...	...		...	...	Two small top shafts.
Rammed clay.	Do.	5000	$2\frac{7}{9}$	104	0	0	0	5	L.L.R. with the strata, and the mass of rock tightly bound in on both sides, which are the reasons given for using so high a charge. The explosion was not violent, but disposed the stones advantageously for loading.
Small stones and earth rammed. Do.	Do. Do.	30,000	$3\frac{3}{4}$	456	0	0	0	$3\frac{1}{2}$	These three charges were fired simultaneously, to bring down a mass of rock having a N.W. face of 171 ft. long. Equivalent charges in common powder would have been respectively 2700, 2920, and 3530 — $\frac{1}{11}$, $\frac{1}{12}$, $\frac{1}{16}$. L.L.R.^{3}. The explosion is described as by no means violent, and the mass generally well thrown out for loading, though some of the stones are in very large pieces. By reference to the plan, it will be seen that the two charges in 51 were distant only 31 ft.

Number of operation	Date of explosion.	Number of quarry.	Depth of shaft.	Length of gallery.	Vertical height from chamber to top of rock to be removed.	Level of floor on chamber with reference to floor of quarry.	Line of least resistance.	Description of powder used.	Charge in pounds.	Proportion of charge to the tube of the line of least resistance.
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.			
53	1851. July 16	3	Not re	corded	... ...	... ...	... ...	Common powder.	450	Not
54	July 16	8	35 0	7 0	Not	recorded	... ...	Do.	1000	Not
55	July 19	4	20 0	57 0	110 0	2 0 below	36 0	Do.	4200	$\frac{1}{11}$
56	July 23	3	20 0	52 0	55 0	3 0 below	24 0	Common merchant's blasting powder.	2600	$\frac{2}{7}$
57	July 24	6	80 0	7 0	80 0	7 0 above	32 0	Do.	3500	$\frac{1}{9}$
58	August 2	4	34 0	18 0	90 0	3 0 below	25 0	Do.	2000	$\frac{1}{8}$

Nature of tamping.	Mode of effecting ignition.	Probable quantity of material procured, in tons.	Quantity of material to each pound of powder, in tons.	Total expense of operation.			Cost of each ton of material.		Remarks.
				£	*s.*	*d.*	*s.*	*d.*	6 in. from centre to crater, not equal to the L.L.R. This operation would not appear to indicate any saving in powder from the simultaneity of explosion. The S.W. end of the mass terminated in a clay fault, and the N.E. end in a natural joint.
recorded	... ...	... ...	... ...	...	...		...	...	Small top shaft, which answered well.
recorded	... ...	... ...	... ...	...	...		...	...	Ditto, ditto, and return gallery. Answered well.
Rammed clay.	Voltaic battery	14,000	$3\frac{1}{3}$	157	4	0	0	$2\frac{1}{2}$	L.L.R. against the strata. Explosion quiet. Stones well thrown out and broken for loading. The large mass of rock which this mine was intended to remove, rising to the height of 110 ft., was allowed to influence the size of the charge, which the result does not show to have been too great. The effect was precisely what had been anticipated.
Do.	Do.	7000	$2\frac{2}{3}$	123	15	0	0	$4\frac{1}{4}$	L.L.R. against the strata, but the charge to act also against a S.E. face, which had proved so troublesome an operation in Nos. 31 and 43. The recollection of this induced the contractor's agent to use so large a charge in the present instance, but I think it was greatly in excess, for the explosion was very violent; large stones were thrown in a N.E. direction (confined by the quarries on the other sides) to a distance of 250 yards, and the principal mass of débris was thrown very far out from the face, as compared with ordinary explosions. The whole of the mass was not removed, a portion being left standing under and to the S.E. of the gallery entrance. The extent cannot yet be discovered, on account of the débris covering it, except just at the face.
Loose stone and earth rammed.	Do.	10,000	$2\frac{6}{7}$	203	8	0	0	$4\frac{3}{4}$	This mine was fired from one of the shafts commenced many months since. The L.L.R. was against the strata and a N.W. face, and the face was also open towards the S.E. and N.E. faces. It was wished to remove  the whole projecting mass, and the charge was consequently made a heavy one. The effect was very good, and fully equal to what had been anticipated. The rock first opened gently in the centre, with an appearance similar to the bursting of the staves of a barrel, the bottom and top followed; and the whole mass was well thrown out for loading. This was the last operation witnessed. To the price per ton, must probably be generally added ½*d.* for the breaking up the large masses of rock into sizes suitable for the breakwater.
Rammed clay.	Do.	Not	estimated	...	...		...	...	Against an open N.W. face. Explosion very violent; large stones projected to a great distance—400 or 500 yards—in a N.W. direction. Charge evidently much in excess.

C. S. HUTCHINSON, Lieut. R.E.
July 31, 1851.

Conclusion.

On these operations, as described by Lieut. Hutchinson, I would add the following few remarks:—

1. In considering the nature of the arrangements in working the quarries at Holyhead, allowance must be made for the circumstances that regulated many of the proceedings, and prevented the course that would produce the best ultimate effects in the shortest time from being always adopted; these were chiefly the necessity for producing the absolute large quantity of material day by day, or at least week by week, without interruption, and, consequently, required explosions to be accelerated, or to be made in particular directions to meet that demand, rather than what would most speedily put the quarries in the best state for working ultimately with most economy.

This will account for what might otherwise appear not to be the most judicious order of proceeding. Consistent with this necessity, the most desirable end was still never lost sight of.

2. The amount of charges applied to these mines must not be taken as a guide in estimating the best proportion for producing the effect of merely bringing the rock down, for which $\frac{1}{32}$ in lbs. of powder of the cube of the line of least resistance in feet would be sufficient.

It was found by experience, that the work was more rapidly and more economically performed by lodging the charge full as low as the line of the floor or roadway of the quarry, by which the root of the rock down to that level was thoroughly broken up, although requiring a greatly increased charge, which was still further augmented to what would as much as possible break up the material at once into manageable masses; in short, the only limit to the amount of charge for the most beneficial effect, would be the largest that would not scatter the material to a distance, nor reduce it to fragments too small for the pier work.

By this course, the work of excavating shafts and galleries, and boring holes, is reduced in the expense of consumption of powder, to a great saving of time and expense.

3. It is apprehended that, on the large scale of the works at Holyhead, and by the circumstances of the quarries generally, the material was produced in a state fit for removal, at least at half the expense which it had previously cost by the ordinary blasting, and to an amount per day that could hardly have been accomplished at all by that mode.

J. F. B.

PLATE I.

HOLYHEAD.

IONS OF GROUND AVAILABLE FOR QUARRIES FOR STONE TO THE BREAKWATER NOW BEING CONSTRUCTED.

---

dmiralty property is shewn by the dotted lines. —·—·—·—·—·—·—
ies on the 29th July 1851 is shewn thus
thus............shew their face on the 1st Novr 1850 before the explosion of any mines
e mines in the order of their explosion. & are used for reference in the report &c
in progress or completed are marked in black.

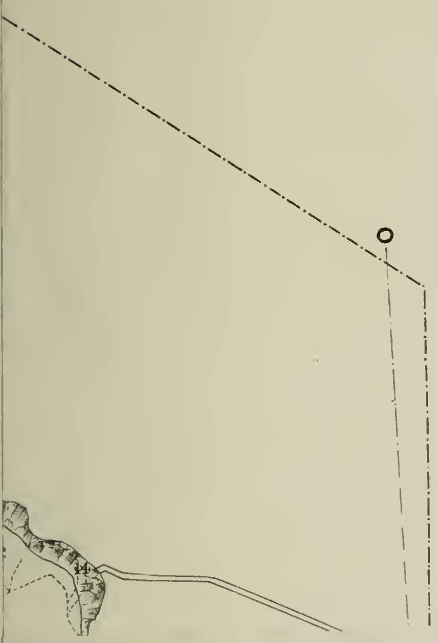
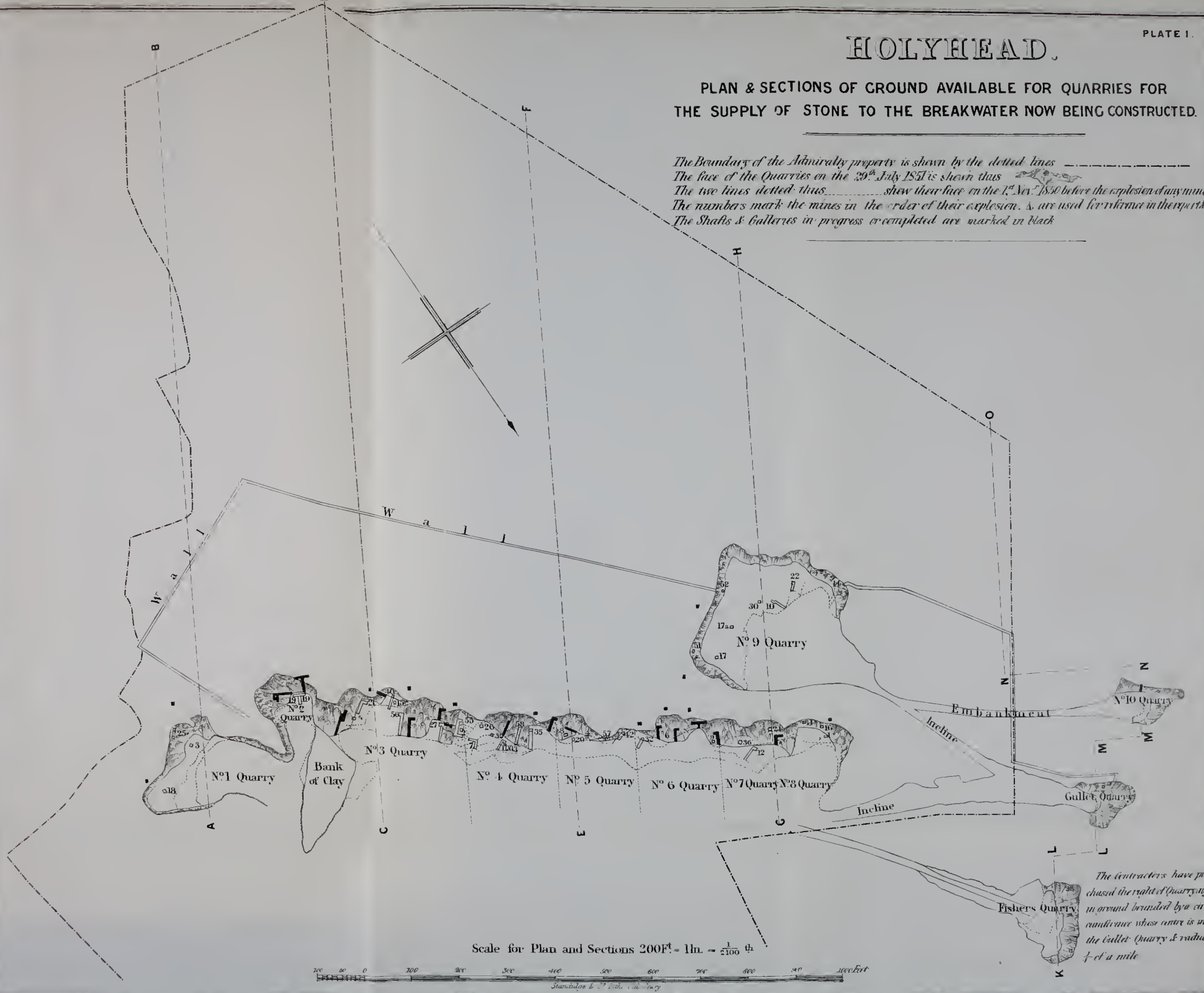


PLATE I.

HOLYHEAD.

PLAN & SECTIONS OF GROUND AVAILABLE FOR QUARRIES FOR THE SUPPLY OF STONE TO THE BREAKWATER NOW BEING CONSTRUCTED.

The Boundary of the Admiralty property is shewn by the dotted lines —·—·—·—·—
The face of the Quarries on the 29th July 1851 is shewn thus
The two lines dotted thus............shew their face on the 1st Nov. 1850 before the explosion of any mines
The numbers mark the mines in the order of their explosion. & are used for reference in the report &c
The Shafts & Galleries in progress or completed are marked in black

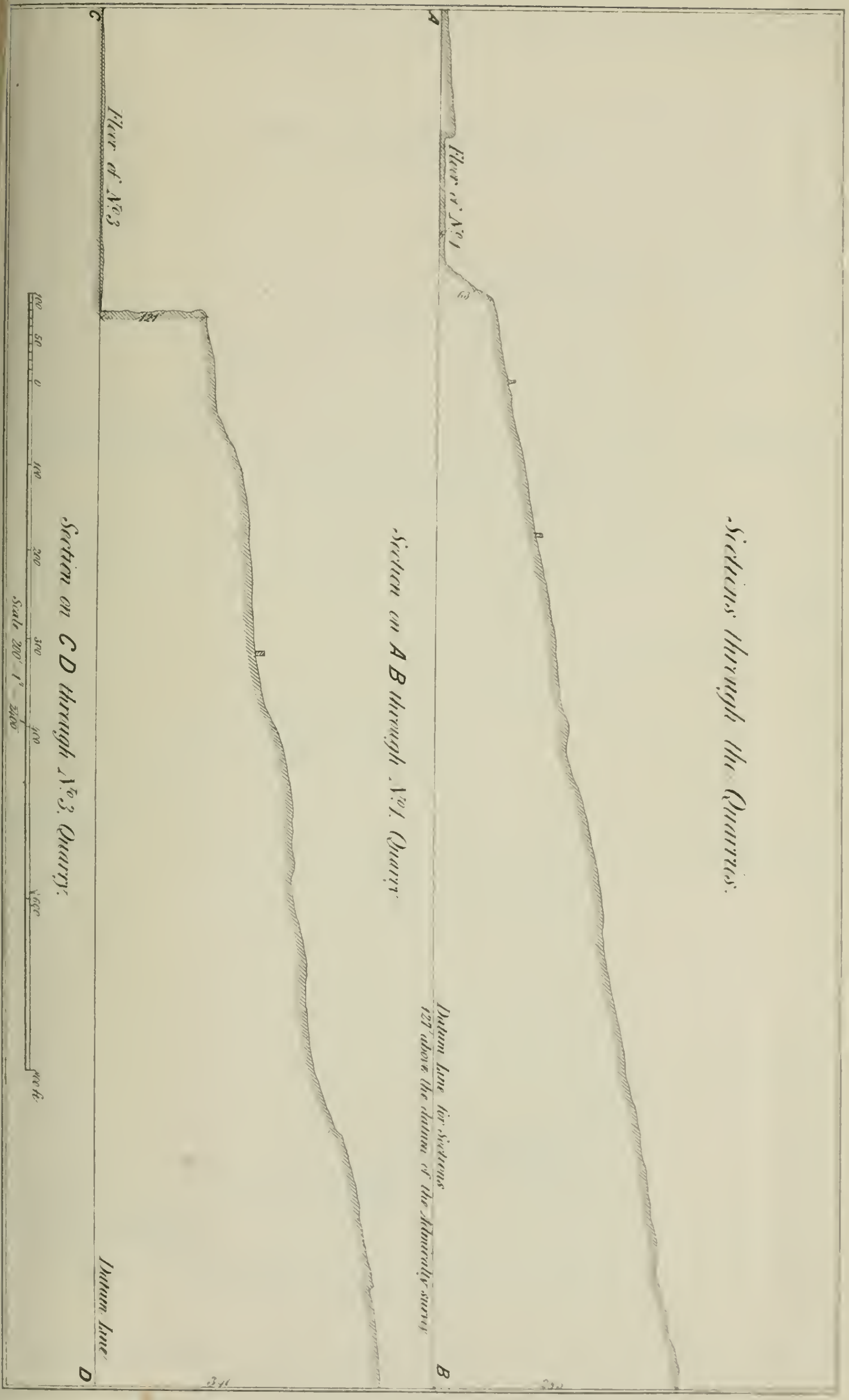


The Contractors have purchased the right of Quarrying in ground bounded by a circumference whose centre is in the Gullet Quarry & radius ¼ of a mile

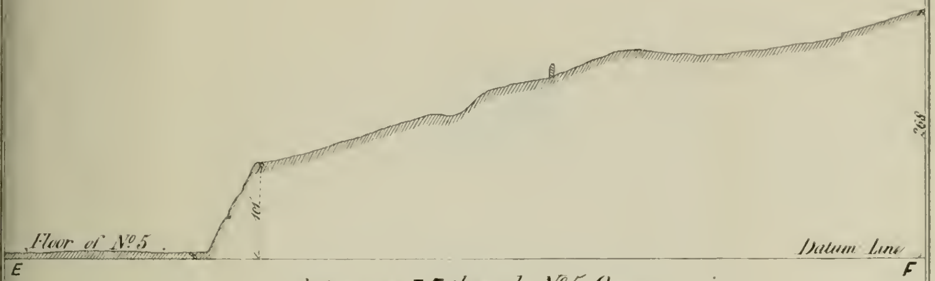
Scale for Plan and Sections 200Ft = 1In = $\frac{1}{2400}$th

100 50 0 100 200 300 400 500 600 700 800 900 1000 Feet

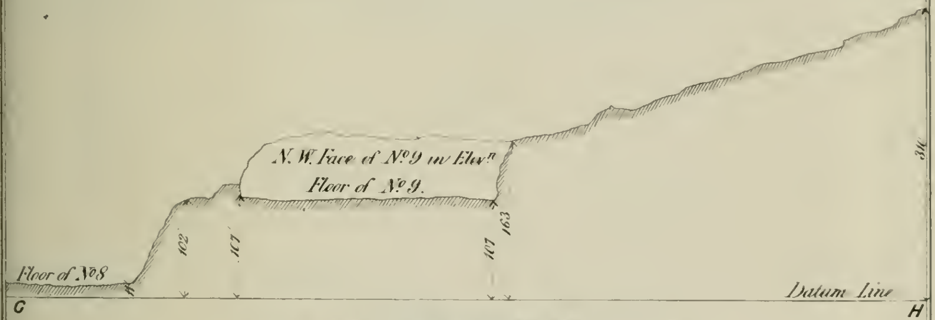
Standidge & C° [illegible]


Sections through the Quarries.
Section on A B through No. 1 Quarry.
Section on C D through No. 3 Quarry.
A
B
C
D
Floor of No. 1
Floor of No. 3
63
121
Datum line for Sections
127 above the datum of the Admiralty survey
Datum line
341
332
100 50 0 100 200 300 400 500 600 ft.
Scale 200' = 1" 1/2400

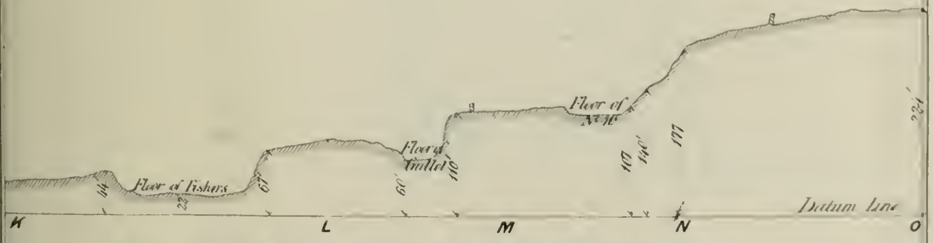
Sections through the Quarries.



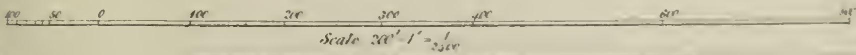
Section on EF through No. 5 Quarry



Section on GH through Nos. 8 & 9 Quarries.

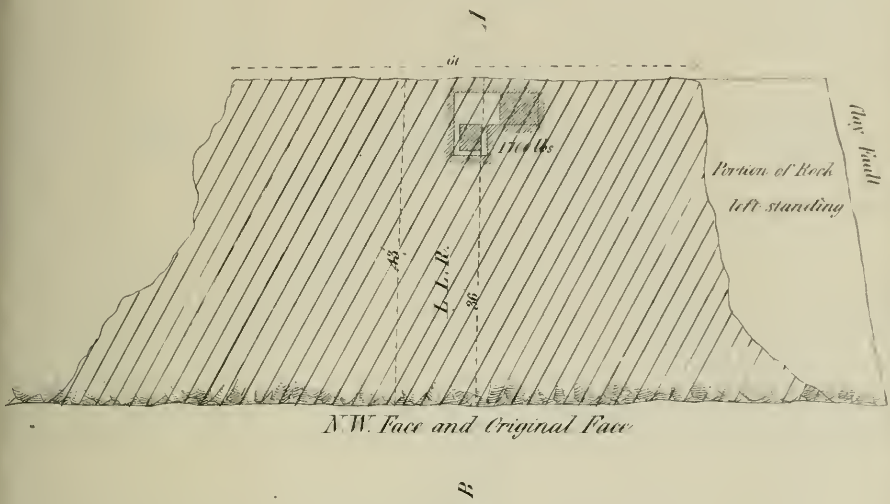


Section on KLMNO through Fishers, Gullet & No. 10 Quarries

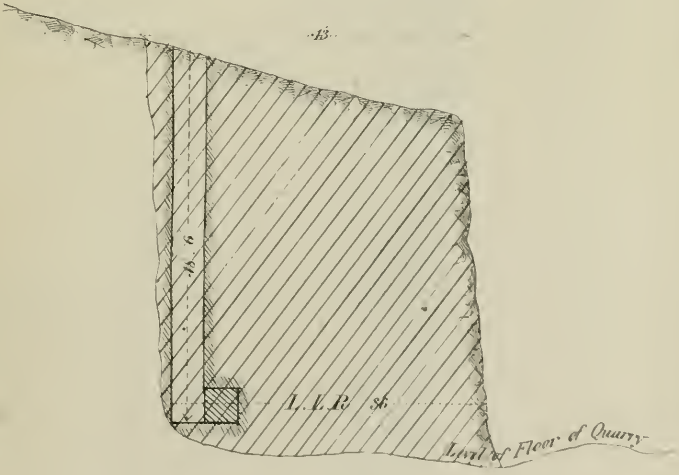


MINE Nº 3. QUARRY Nº 1.

Fired 30th Novr 1850.



Plan



Section on A B

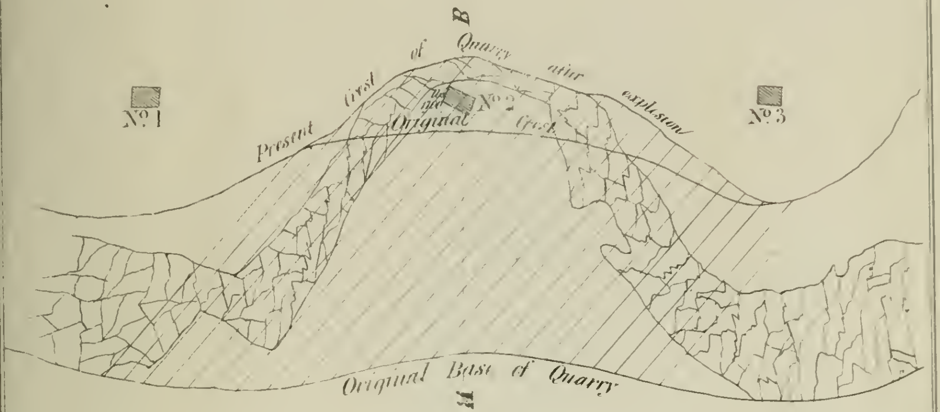
Scale 25 = 1"

Note. The part shaded represents the mass removed.

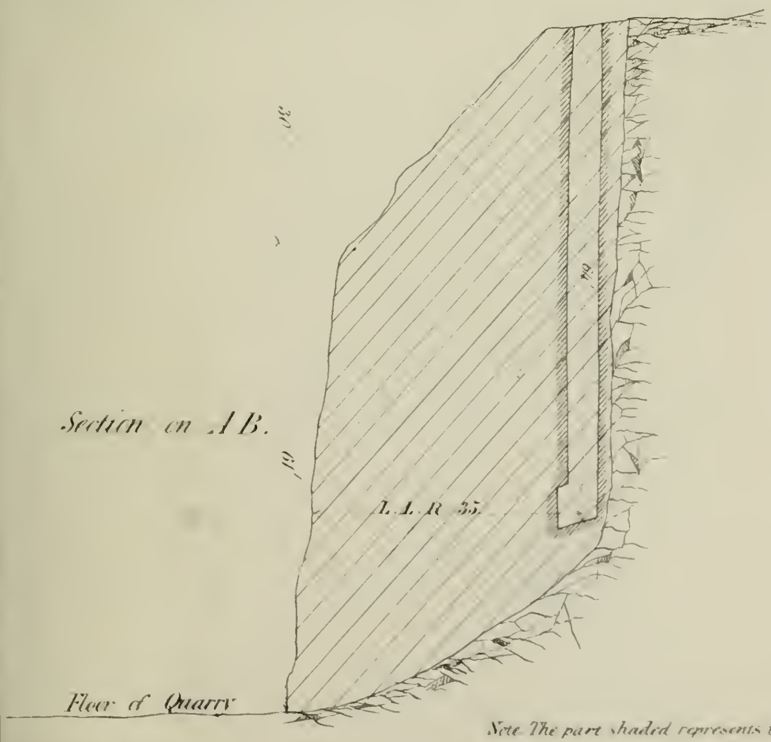
MINE Nº 4 SHAFT Nº 2. QUARRY Nº 5.

Fired 7th Decr. 1850.

Scale, 1 Inch = 25 feet.



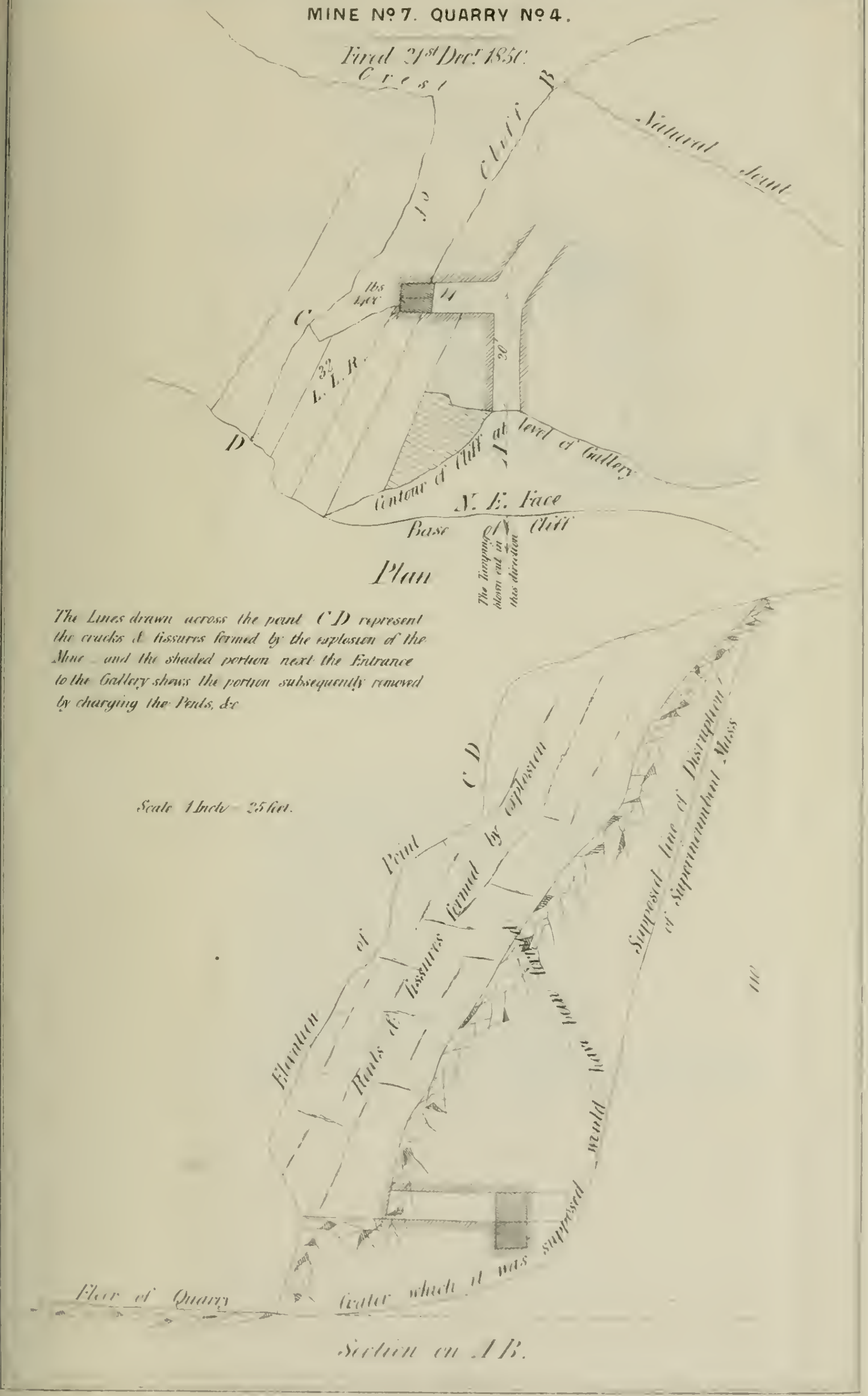
Plan



Section on A B.

Note. The part shaded represents the mass removed

MINE No. 7. QUARRY No. 4.


Fired 21st Decr 1850.
Crest
Top Cliff
B
Natural Joint
lbs 1,400
11
C
32
L. L. R.
30
D
Contour of Cliff at level of Gallery
A
N. E. Face
Base of Cliff
The Tamping blown out in this direction
Plan
Elevation of Point C D
Rents & Fissures formed by explosion
Supposed line of Disruption of Superincumbent Mass
110
Crater which it was supposed would have formed
Floor of Quarry
Section on A B.

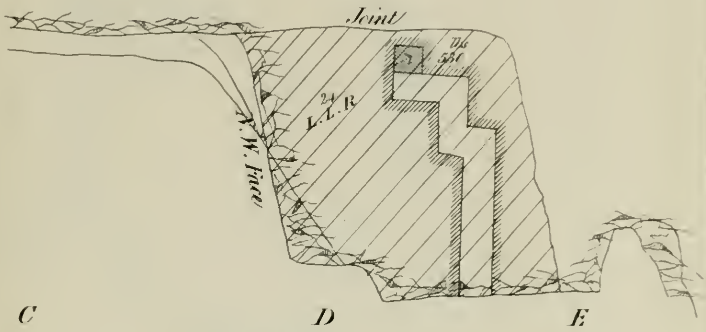
The Lines drawn across the point C D represent the cracks & fissures formed by the explosion of the Mine – and the shaded portion next the Entrance to the Gallery shows the portion subsequently removed by charging the Pents, &c

Scale 1 Inch = 25 feet.

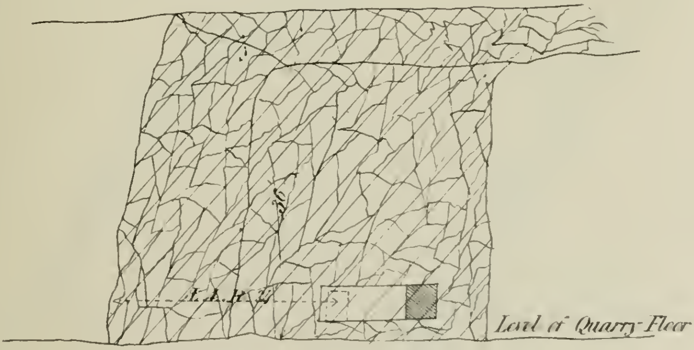
MINE Nº 10. QUARRY Nº 9.

Fired 16th Jany 1851.

Scale, 1 Inch = 25 feet.



Plan

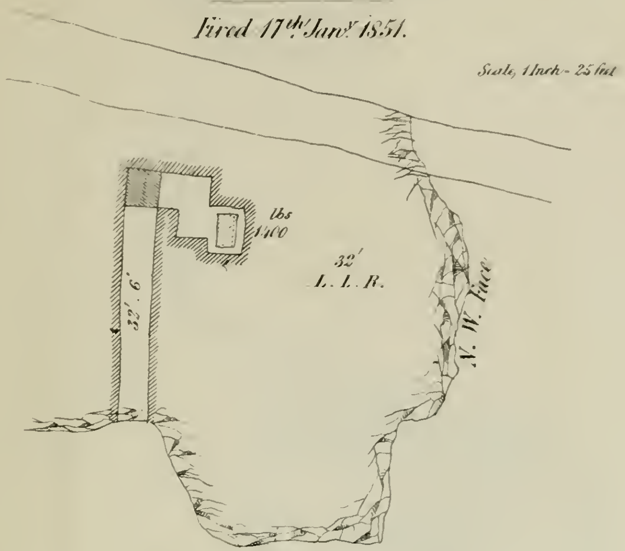


Elevation on C D E.

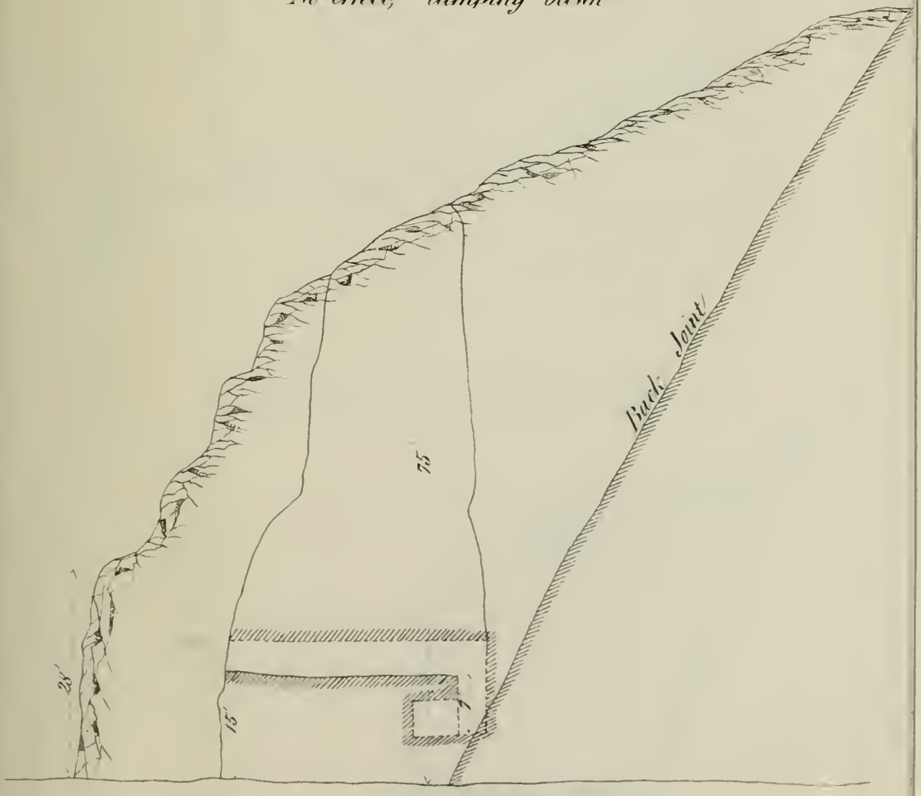
Note. The part shaded represents the mass removed.

MINE No II. QUARRY No 4.

Fired 17th Jany 1851.



No effect; tamping blown

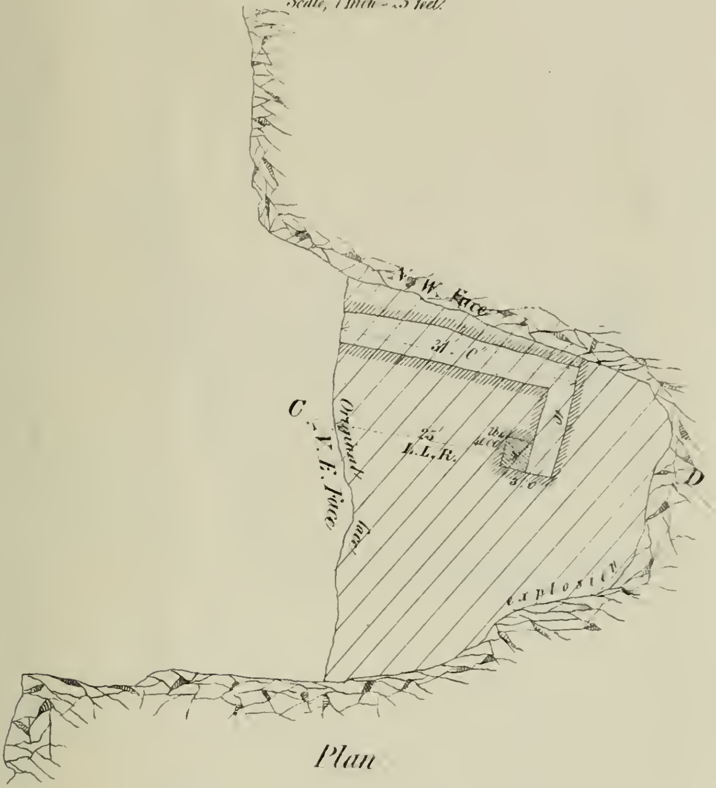


Side Elevation of N.W. Face.

MINE No 14. QUARRY No 9.

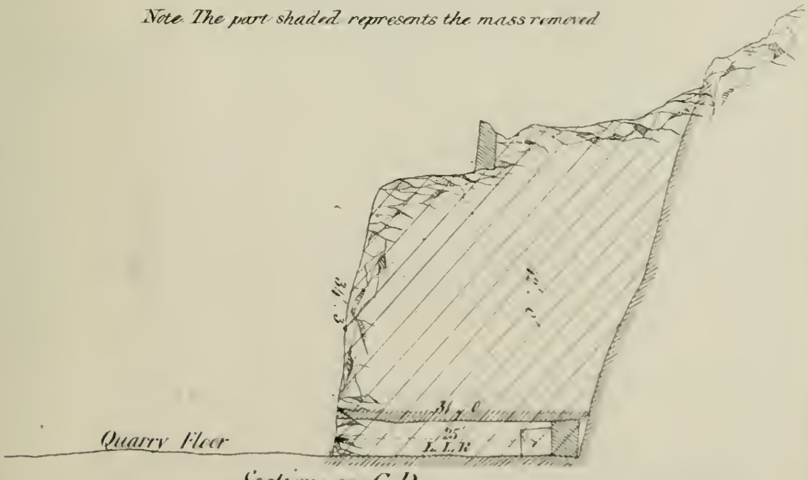
Fired 13th Feby 1851.

Scale, 1 Inch = 25 feet.

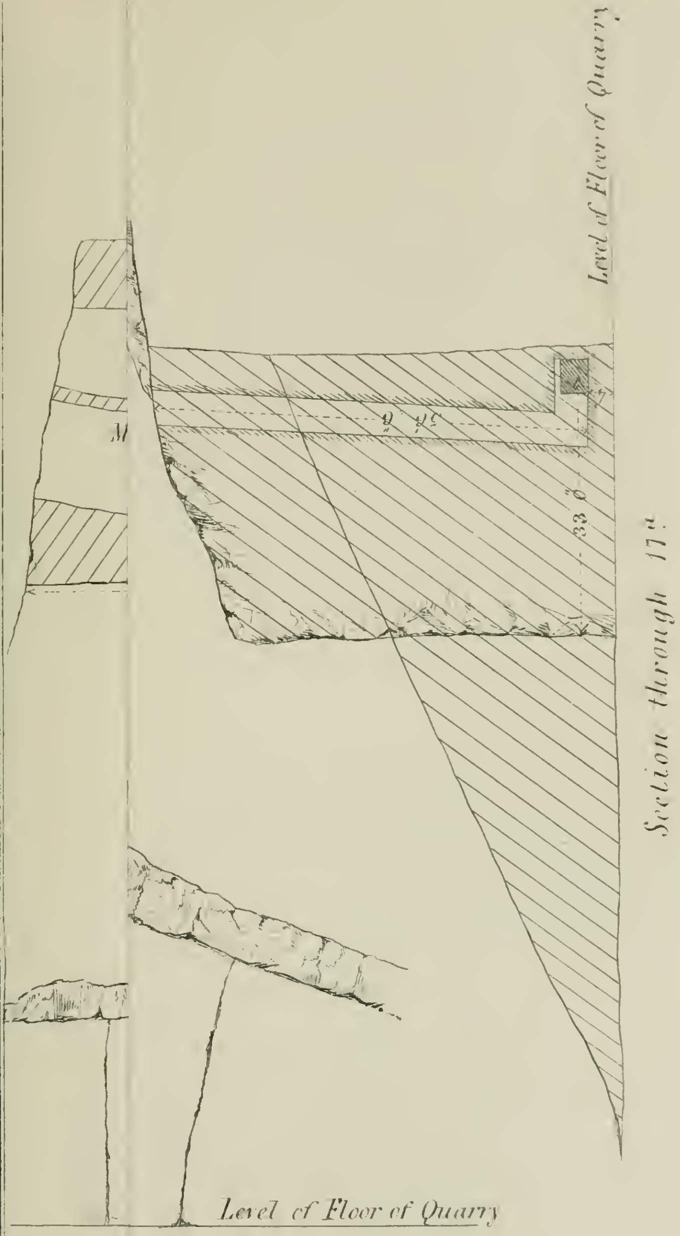


Plan

Note. The part shaded represents the mass removed



Section on C D.

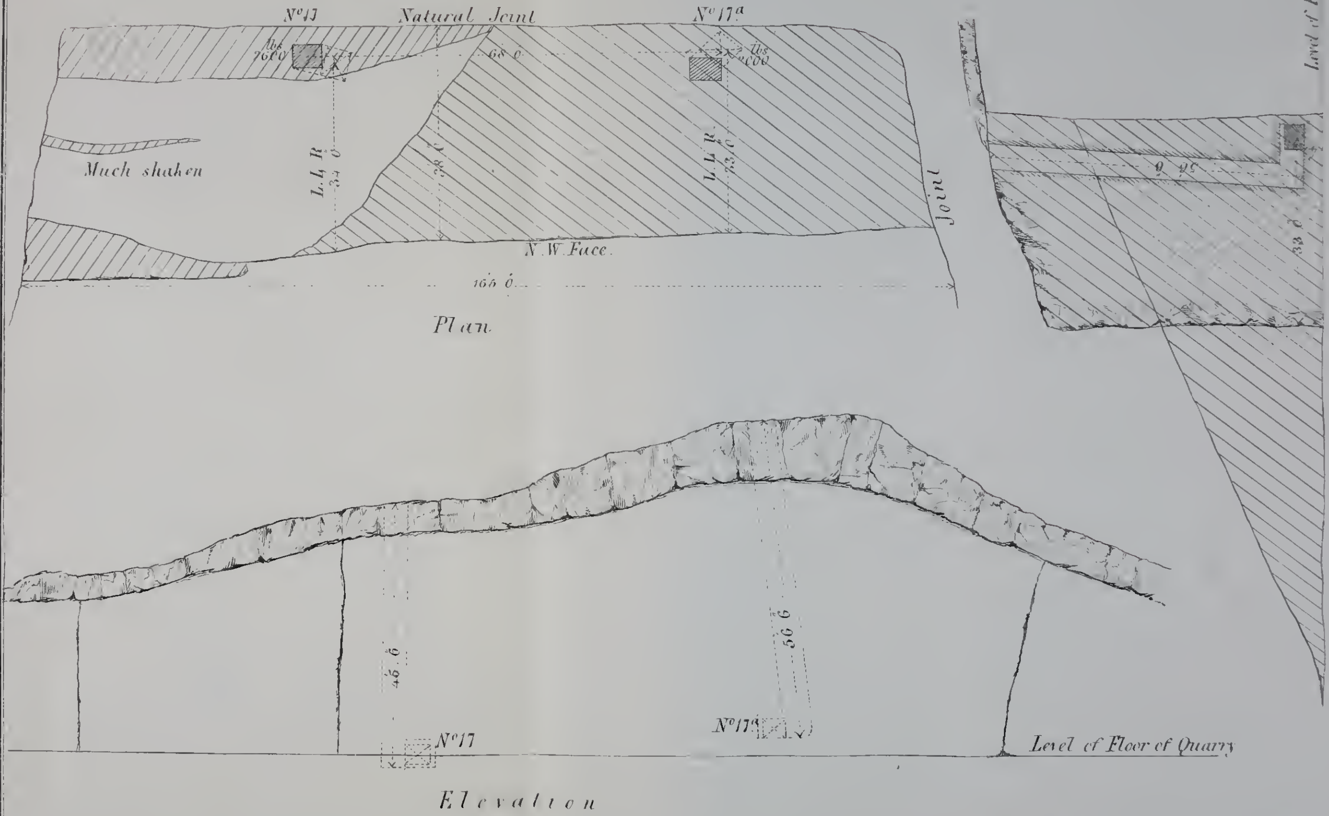


Note. The part shaded represents the mass removed.

Standidge & Co. Lith. London

MINES Nos 17 AND 17a QUARRY No 9.

Fired 24th & 25th Feby 1851.

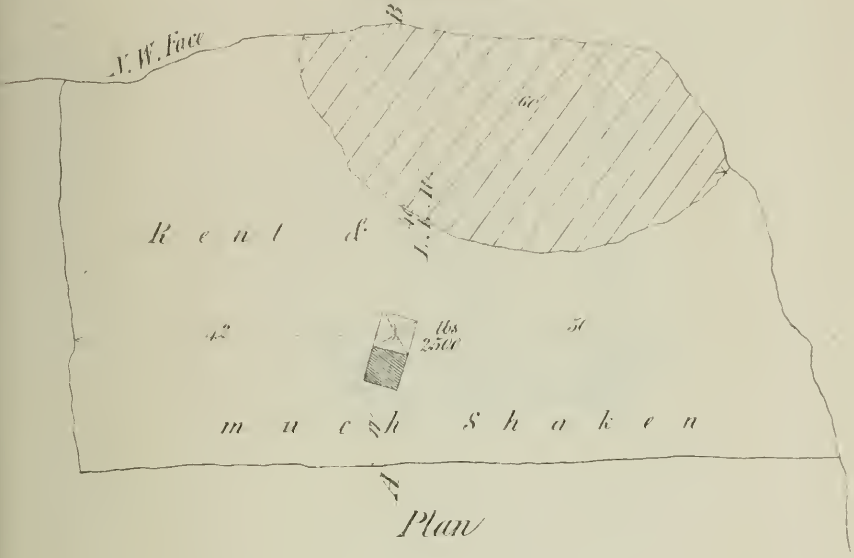


Note The part shaded represents the mass removed

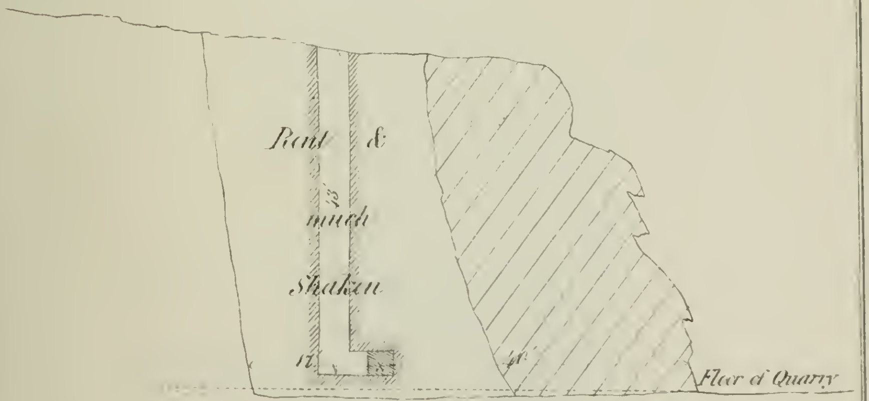
MINE No 18. QUARRY No 1.

Fired 1st March, 1851.

Scale 1 Inch 25 feet:



Plan



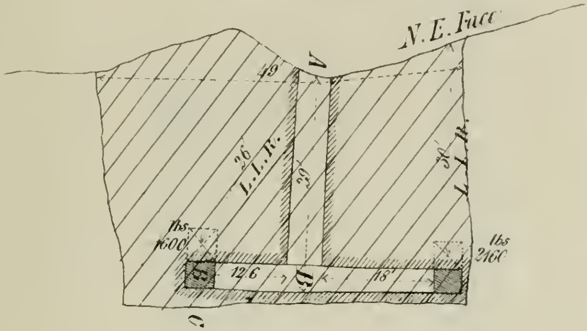
Section on A B.

Note The part shaded represents the mass removed

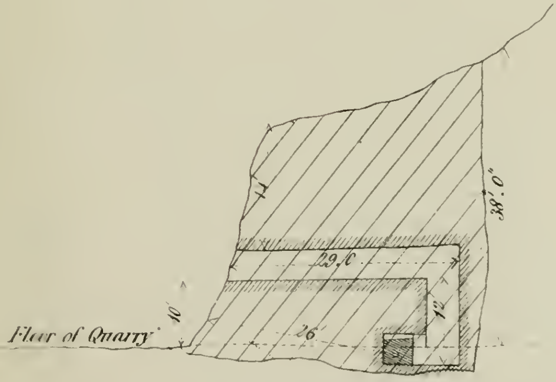
MINE No. 19. QUARRY No. 2.

Fired 15th March, 1851.

Scale, 1 Inch = 25 feet.



Plan

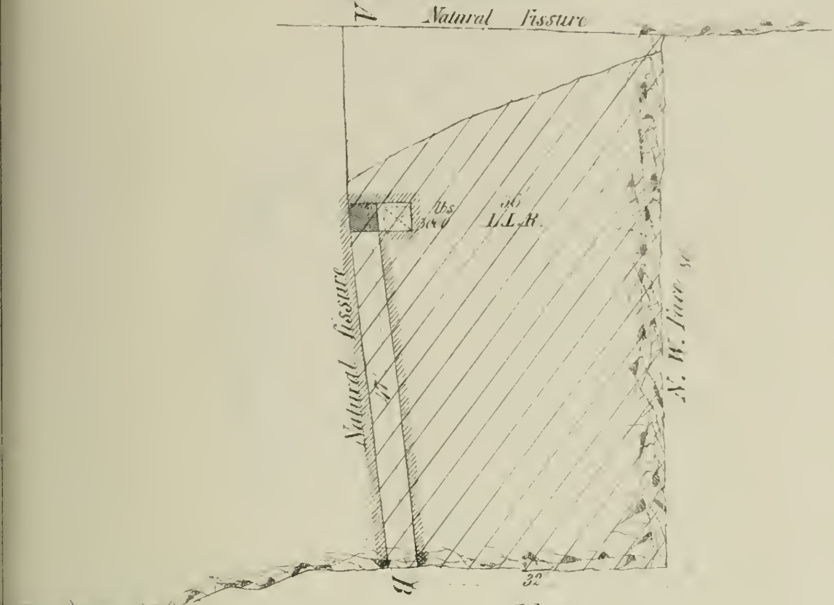


Section on A B C.

Note. The part shaded represents the mass removed.

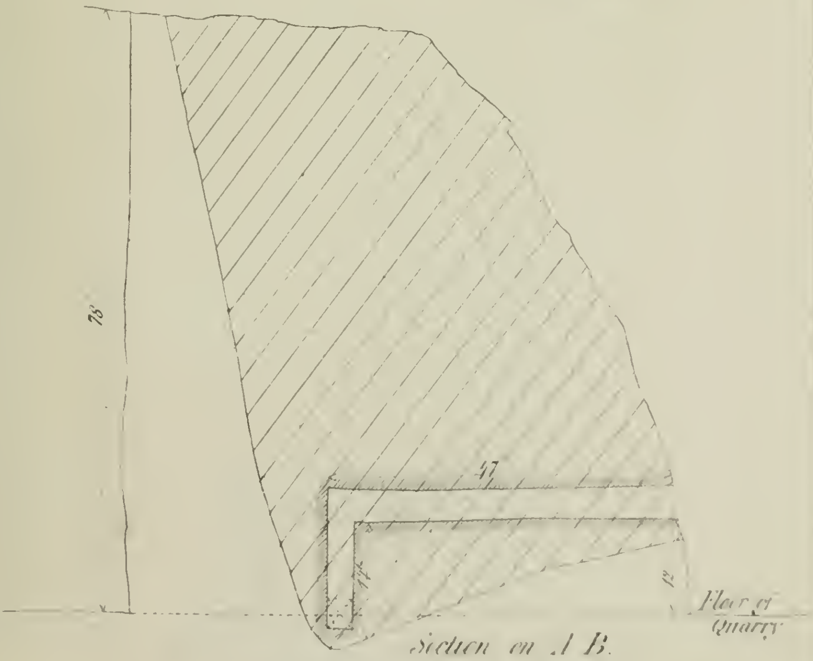
MINE No 20. QUARRY No 5.

Fired 19th March, 1851.



Plan

Scale 1 Inch = 25 feet.



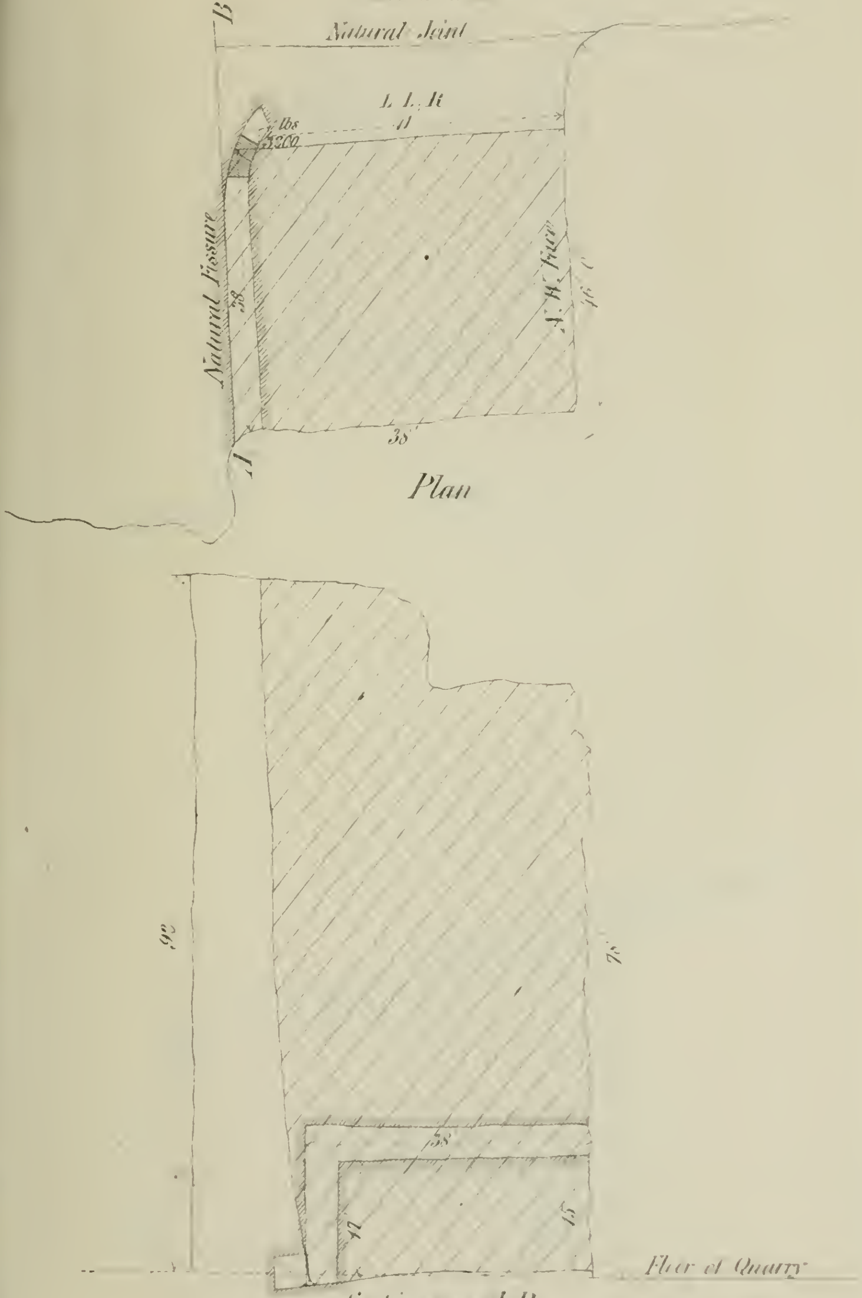
Section on A B.

Note The part shaded represents the mass removed

MINE No 21. QUARRY No 3.

Fired 4th April, 1851.

Scale 1 Inch = 25 feet.

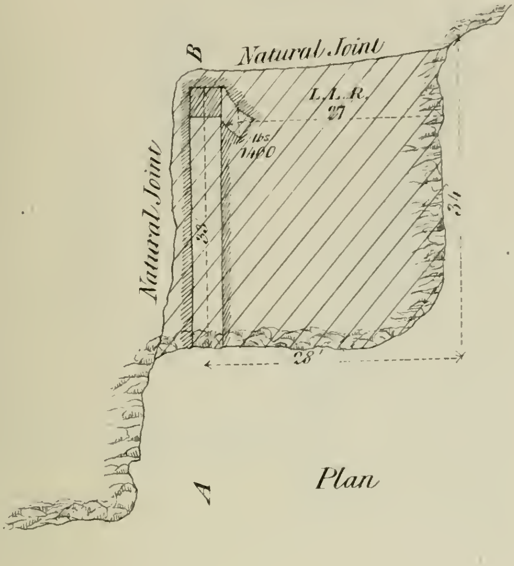


Section on A B.

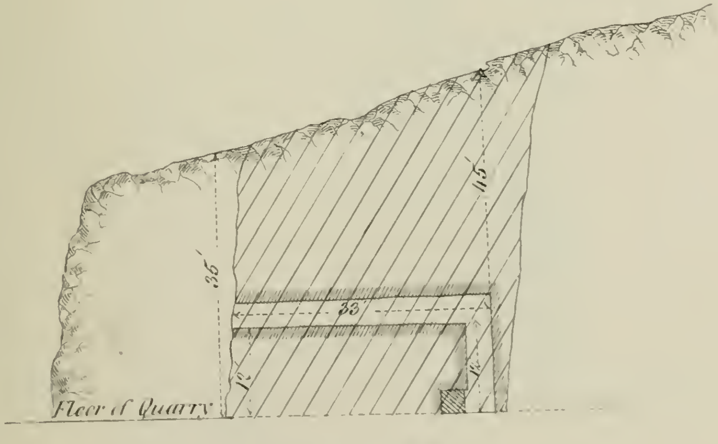
Note The part shaded represents the mass removed.

MINE No. 22. QUARRY No. 9.

Fired 5th April 1851.



Plan

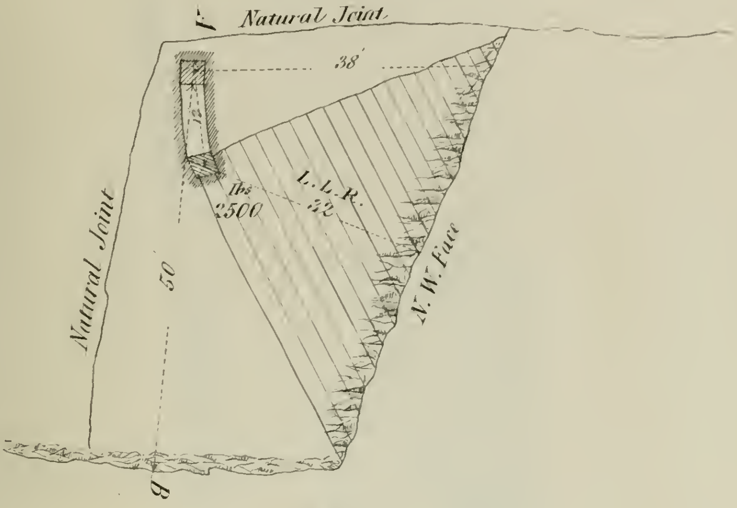


Section on A.B.

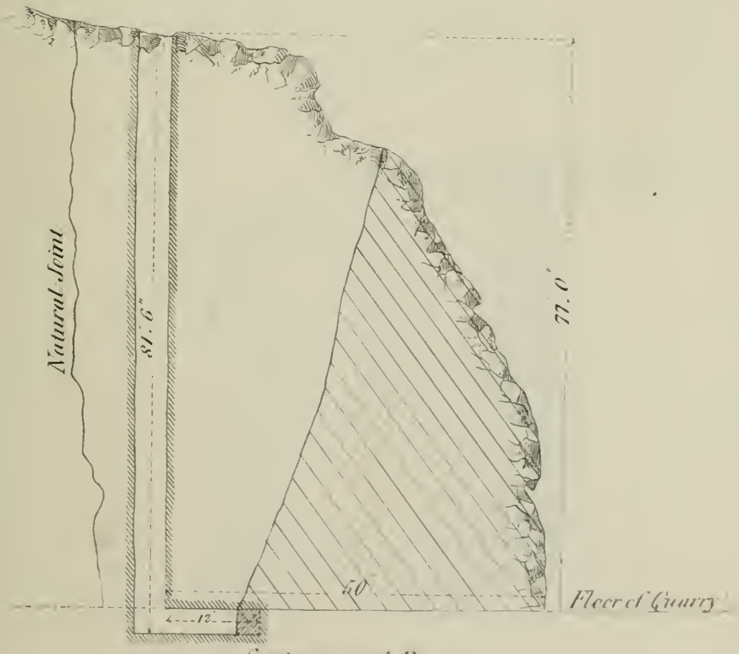
Note The part shaded represents the mass removed

MINE No. 24. QUARRY No. 8.

Fired 15th April 1851.



Plan

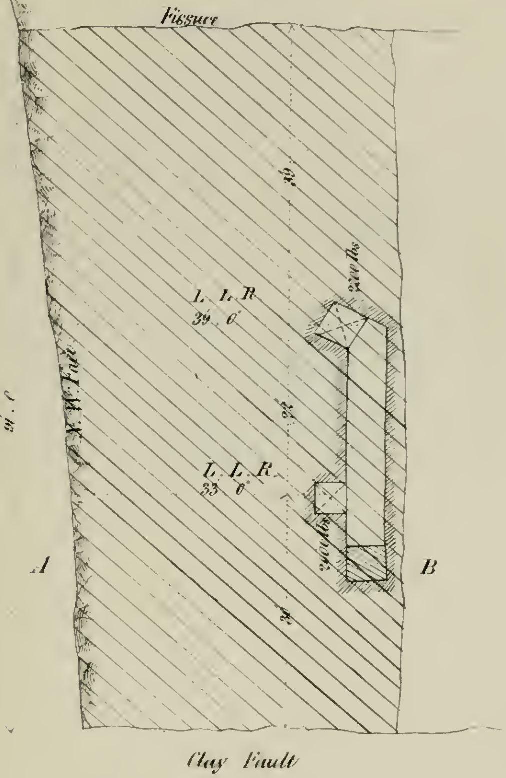


Section on A.B.

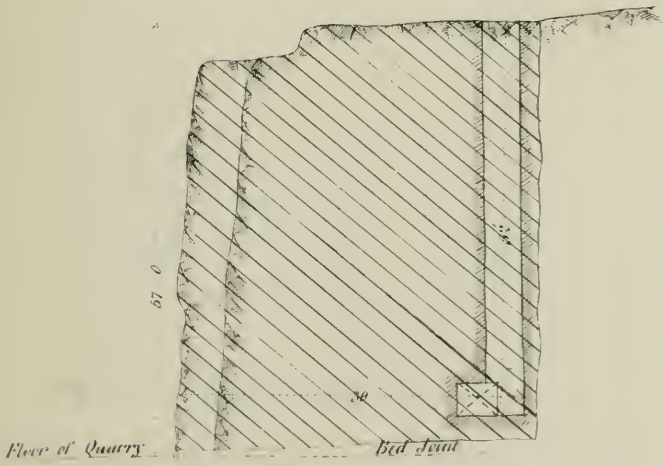
Note. The part shaded represents the mass removed.

MINE Nº 25. QUARRY Nº 1.

Fired 22nd April 1851.



Plan



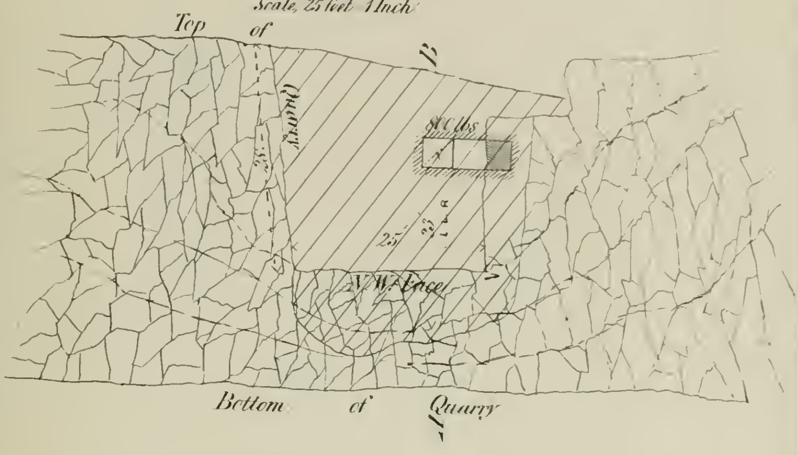
Section on A. B.

Note. The part shaded represents the mass removed

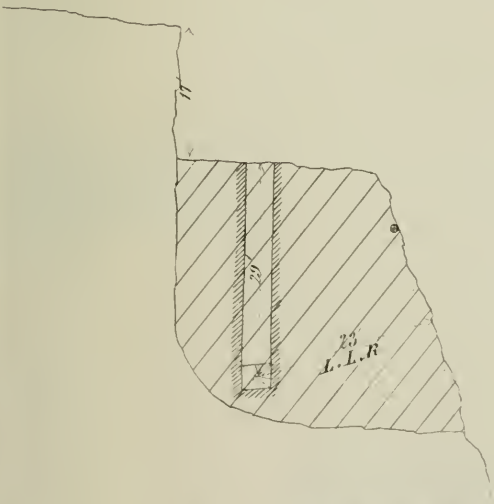
MINE No 26. QUARRY No 4.

Fired 29th April, 1851.

Scale, 25 feet 1 Inch



Plan.



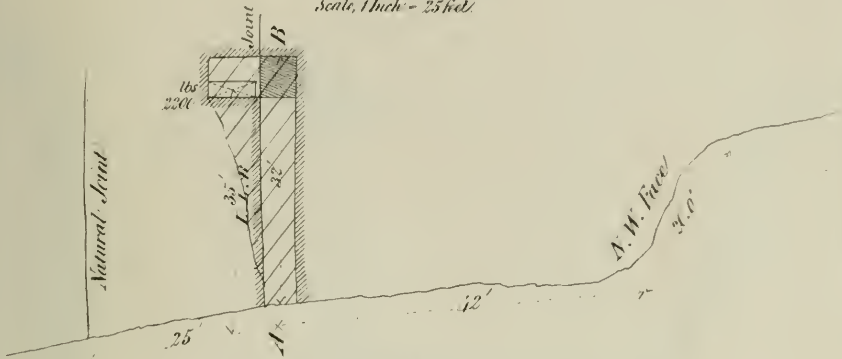
Section on A B.

Note The part shaded represents the mass removed

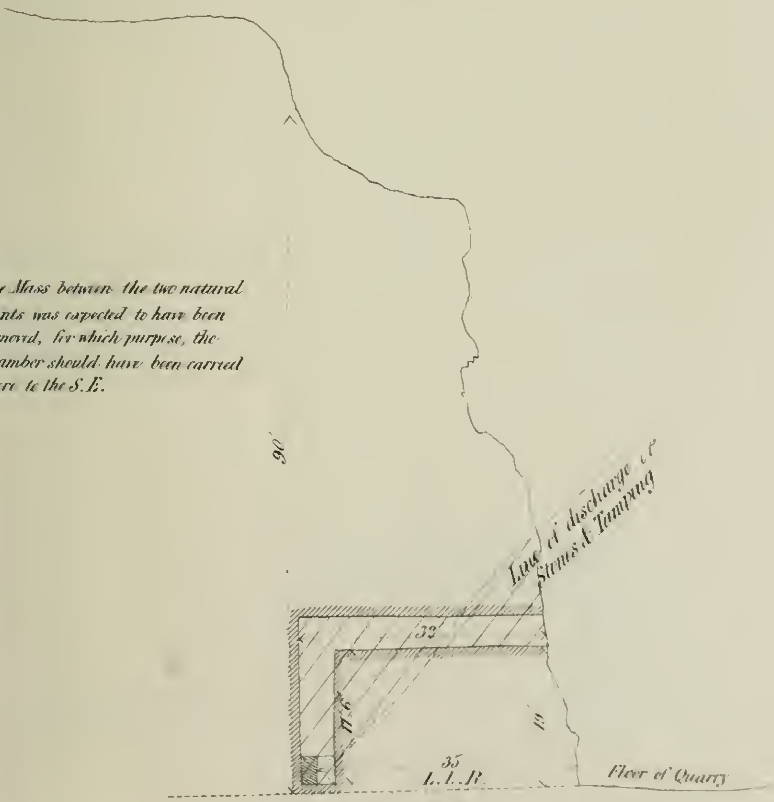
MINE No 27. QUARRY No 3.

Fired; 3rd May, 1851.

Scale, 1 Inch = 25 feet.



Plan



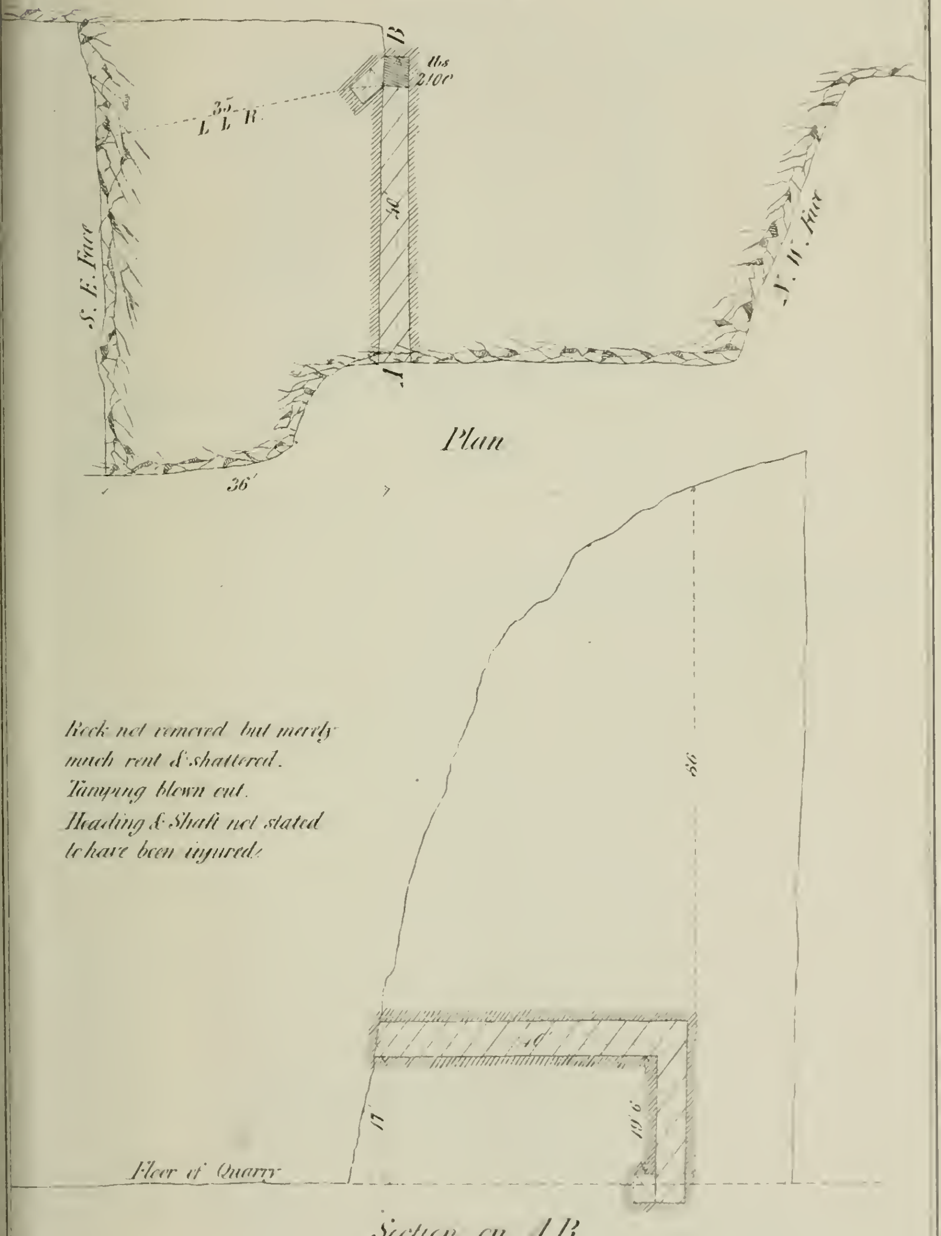
The Mass between the two natural joints was expected to have been removed, for which purpose, the chamber should have been carried more to the S.E.

Section on A B.

MINE No. 31. QUARRY No. 2.

Fired 13th May, 1851.

Scale, 1 Inch = 25 feet



Plan

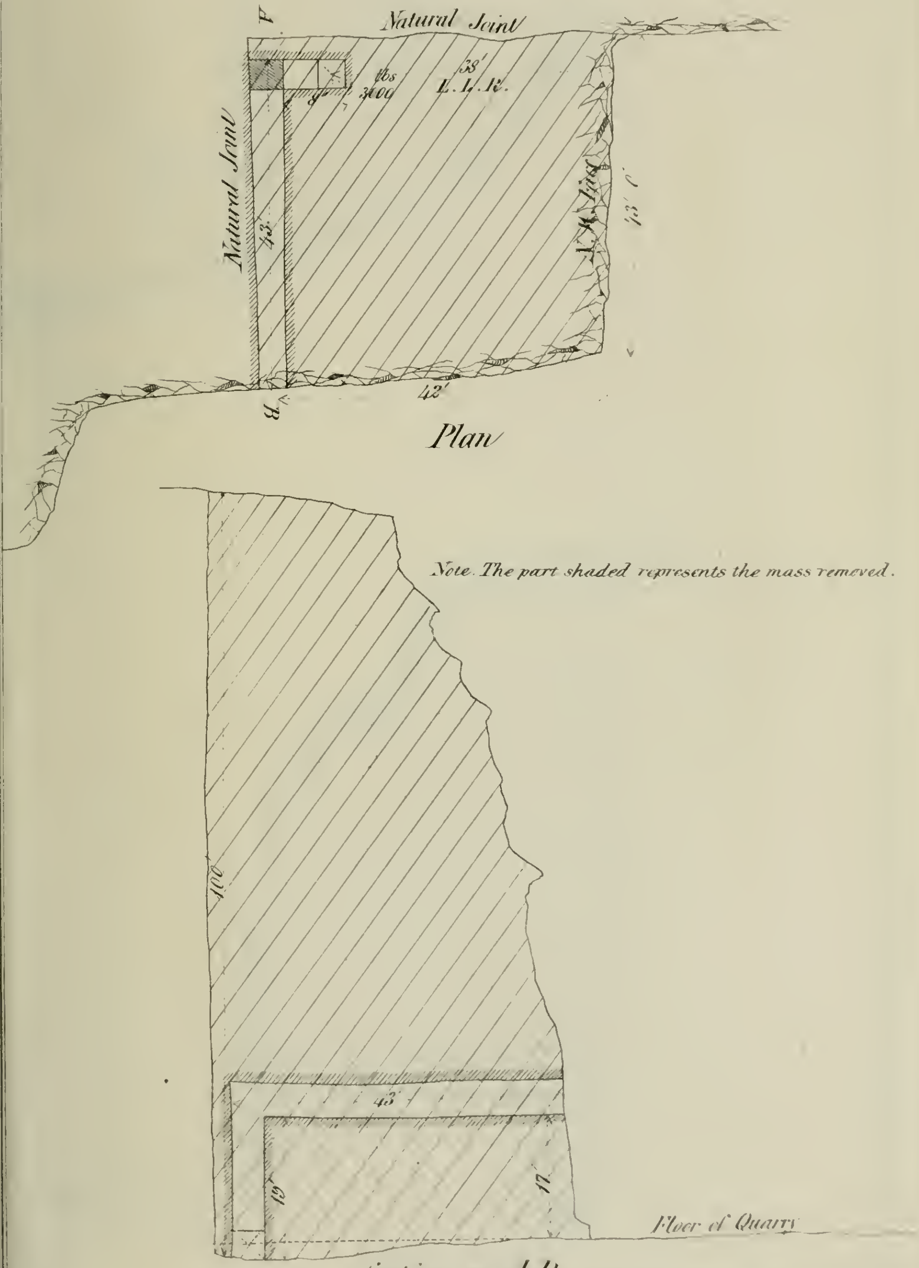
Rock not removed but merely much rent & shattered.
Tamping blown out.
Heading & Shaft not stated to have been injured.

Section on AB.

MINE No. 35. QUARRY No. 4.

Fired 21st May 1851.

Scale, 1 Inch = 25 feet.



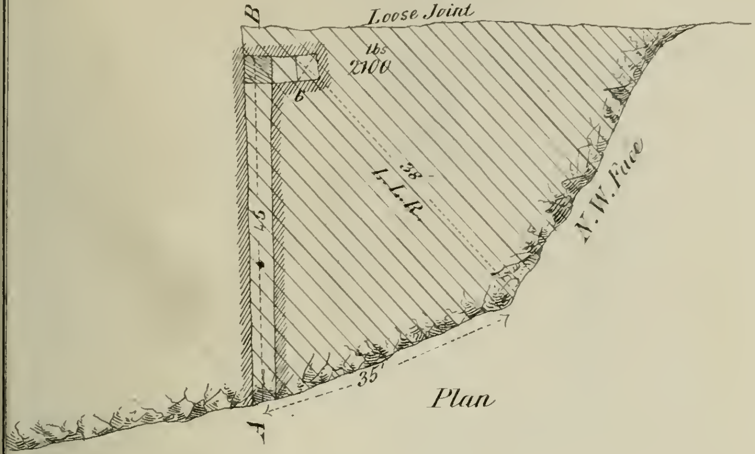
Plan

Note. The part shaded represents the mass removed.

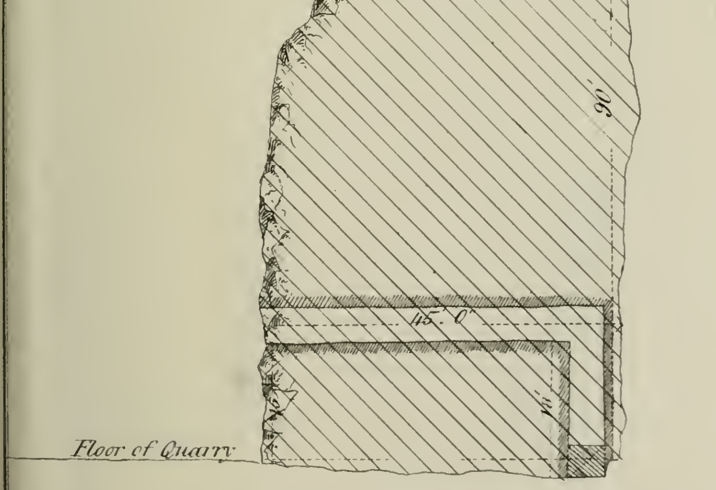
Section on A B.

MINE No. 36 QUARRY No. 7.

Fired 28th May 1851.



Plan



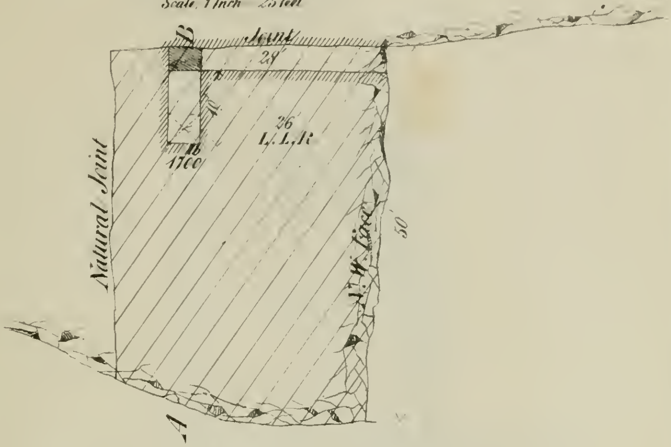
Section on A. B.

Note. The part shaded represents the mass removed

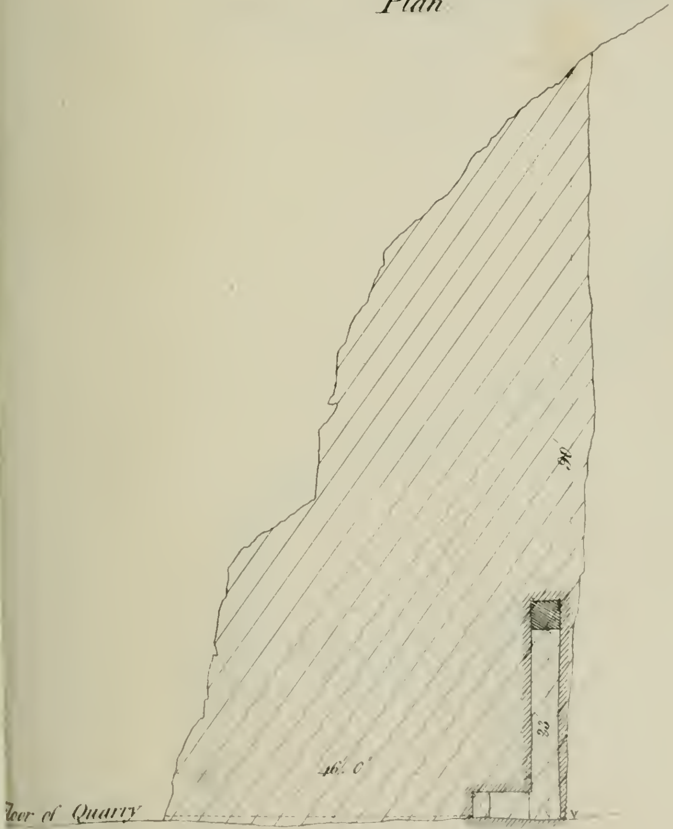
MINE No. 39. QUARRY No. 4.

Fired 3rd June 1851.

Scale, 1 Inch = 25 feet



Plan

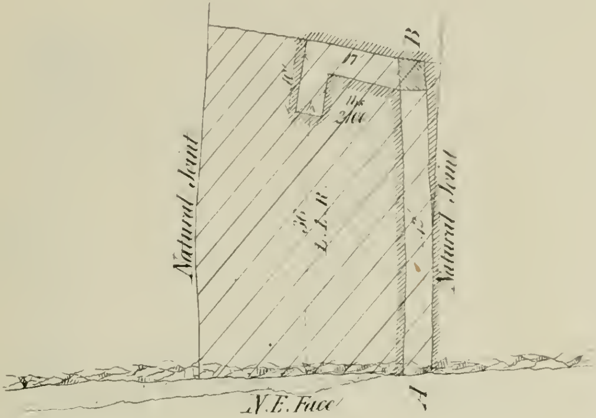


Section on A B.

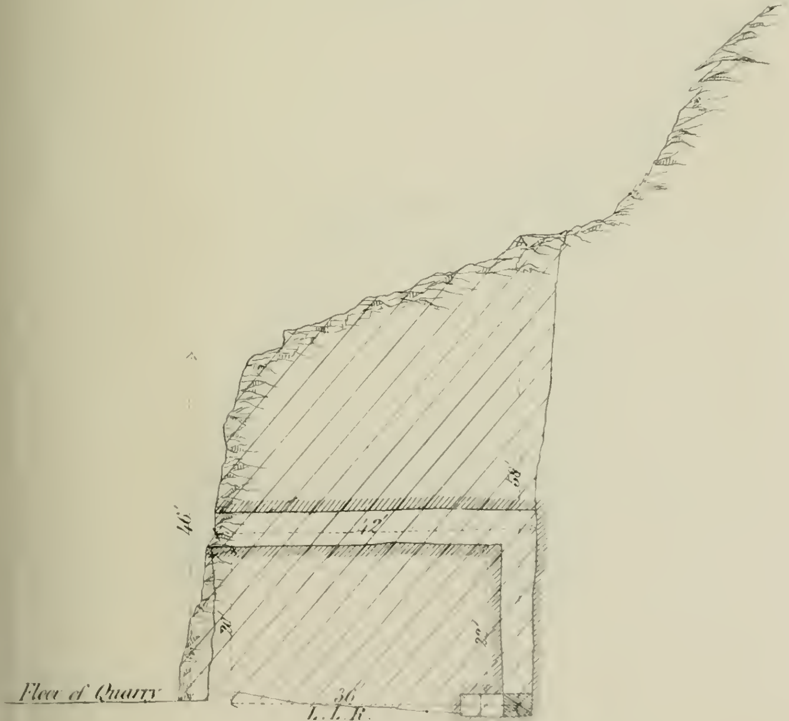
Note The part shaded represents the mass removed

MINE Nº 40. QUARRY Nº 3.

Fired 7th June 1851



Plan

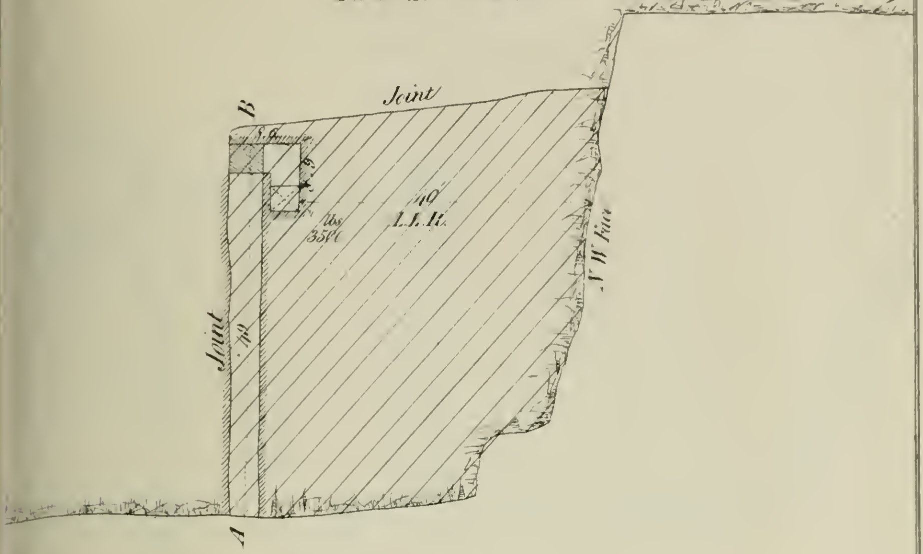


Section on AB.

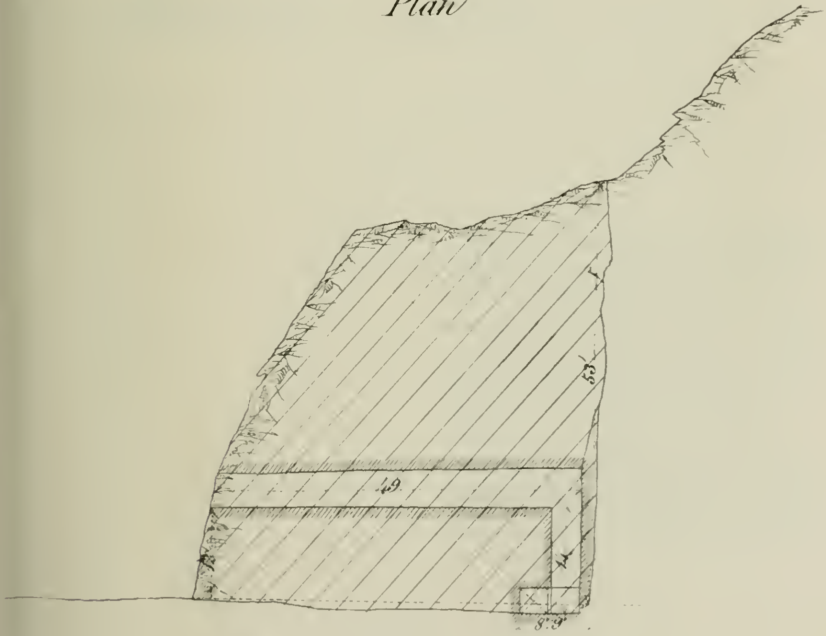
Note The part shaded represents the mass removed

MINE Nº 42. QUARRY Nº 5.

Fired 20th June 1851.



Plan



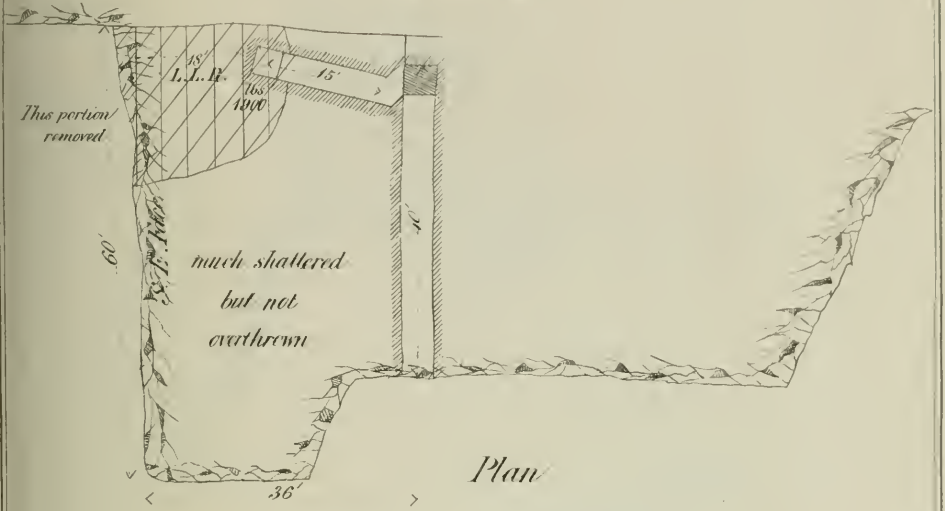
Section on A B.

Note. The part shaded represents the mass removed.

MINE Nº 43. QUARRY Nº 2.

Fired 25th June, 1851.

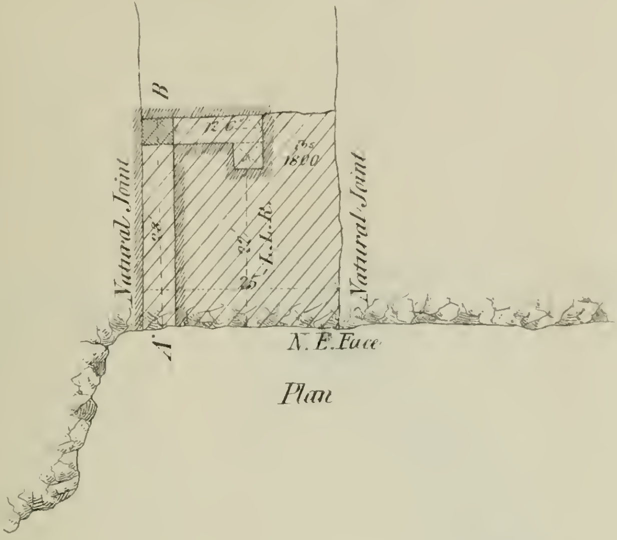
Scale, 1 Inch = 25 feet.



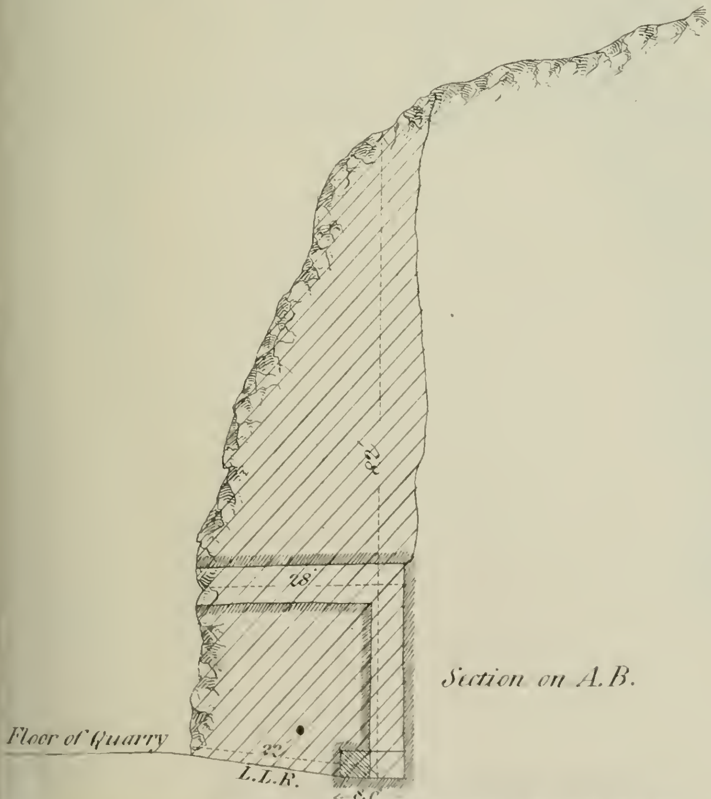
This is the same mass of rock against which Nº 31 was exploded A gallery was run out from the old chamber & a new one formed within 18 ft. of the S.E. Face The effect is described as being tolerably good, considering the Shattered State of the Rock, from the previous explosion The L.L.R. was taken so close to the S.E. Face in order to obtain a solid spot for the Chamber, the previous explosion having so much rent the rock about the old chamber

MINE No 50 QUARRY No 4.

Fired 11th July 1851.



Plan

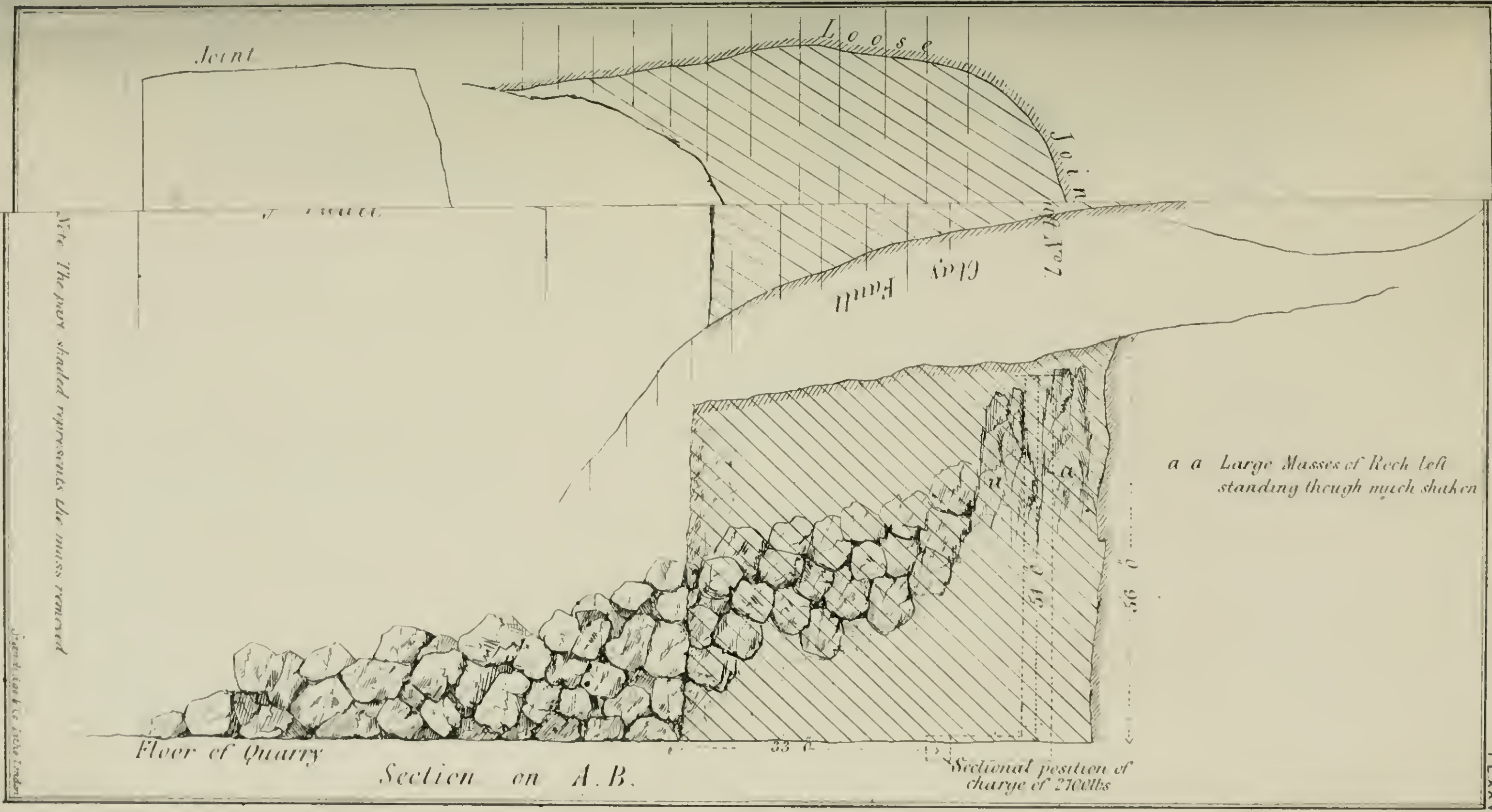


Section on A.B.

Note. The part shaded represents the mass removed

HOLYHEAD QUARRIE

PL.XXVIII.



a a Large Masses of Rock left standing though much shaken

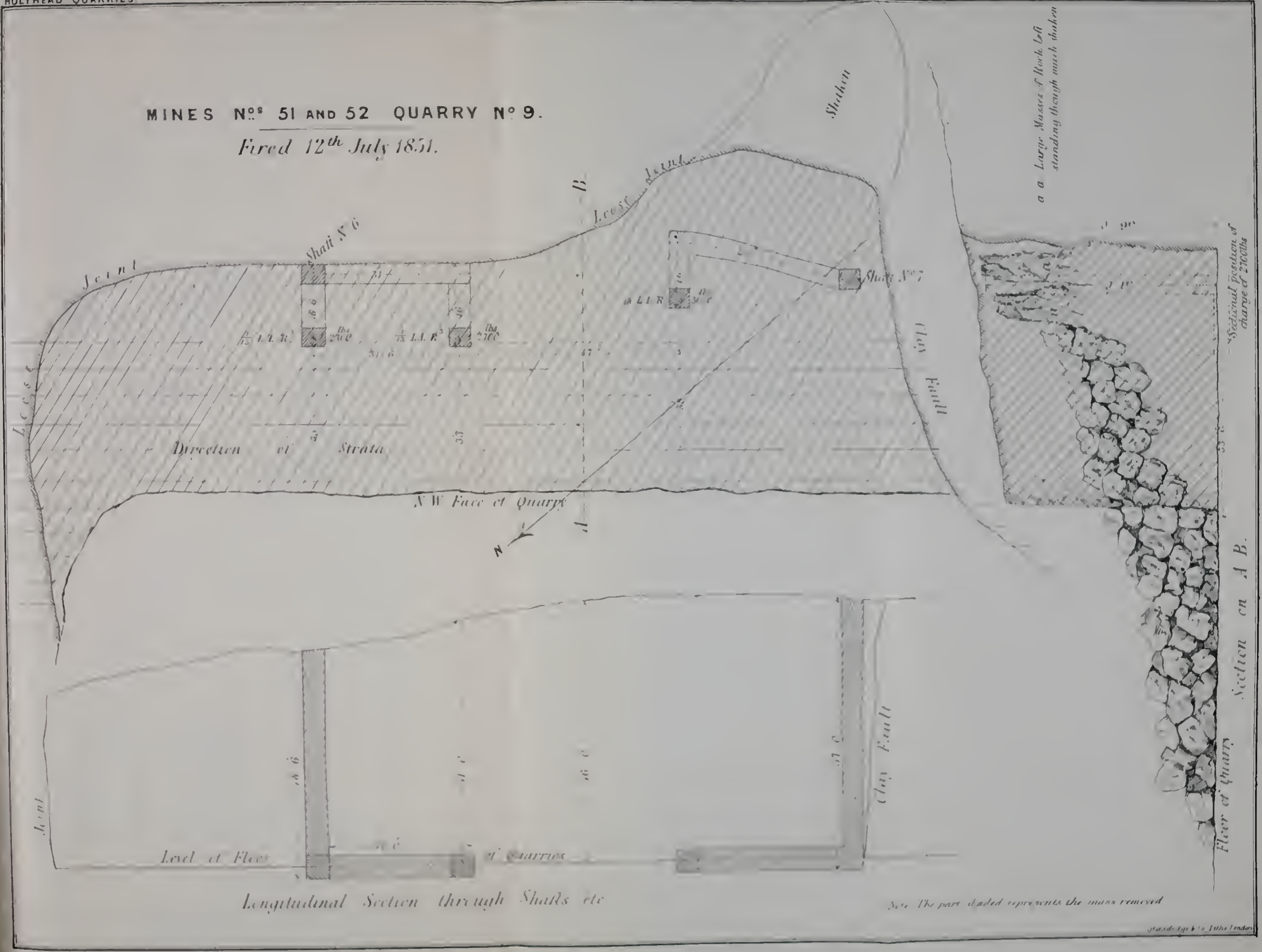
Section on A.B.

Note The part shaded represents the mass removed

[illegible] & Co Litho London

MINES Nos 51 AND 52 QUARRY No 9.

Fired 12th July 1851.



Longitudinal Section through Shafts etc

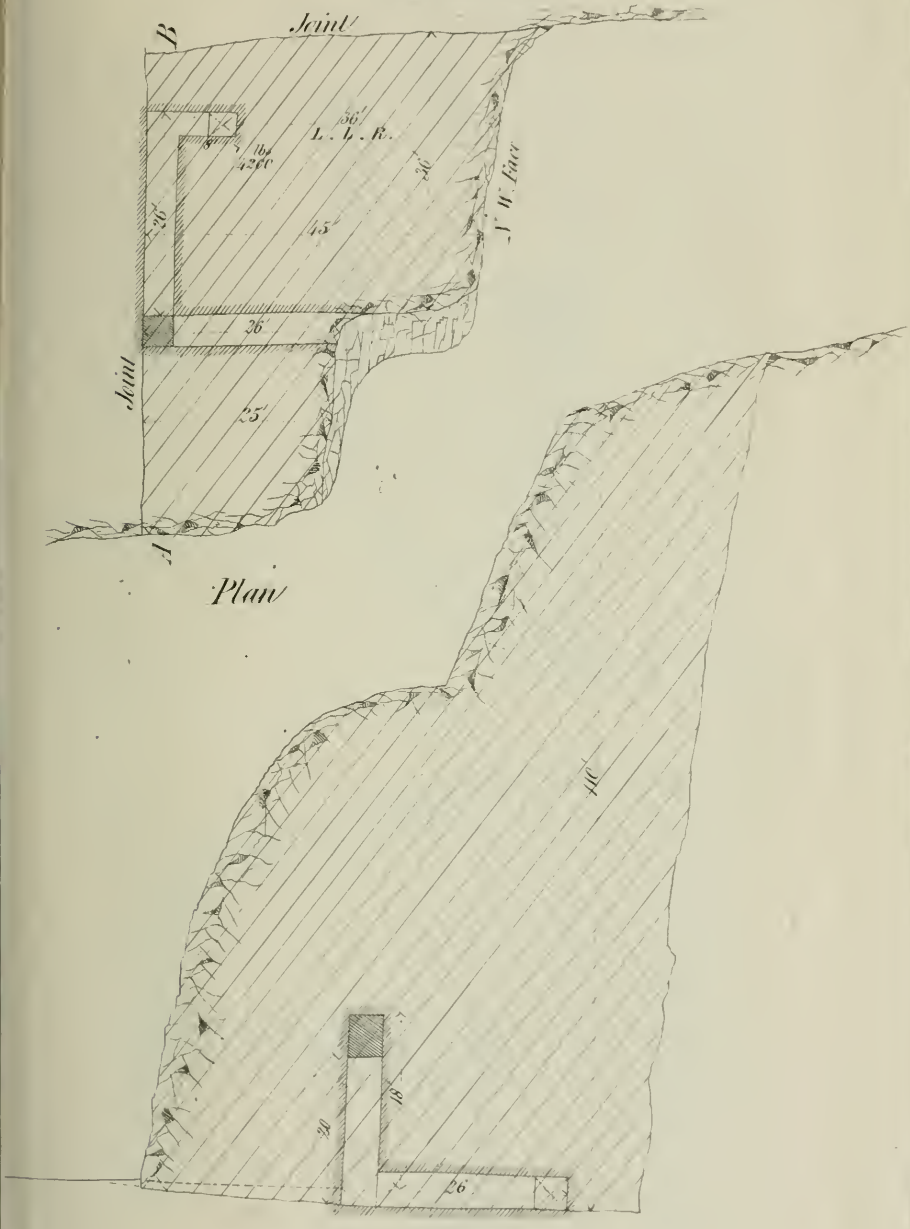
Note. The part shaded represents the mass removed

Standidge & Co. Litho. London

MINE No. 55. QUARRY No. 4.

Fired 19th July 1851.

Scale, 1 Inch = 25 feet



Plan

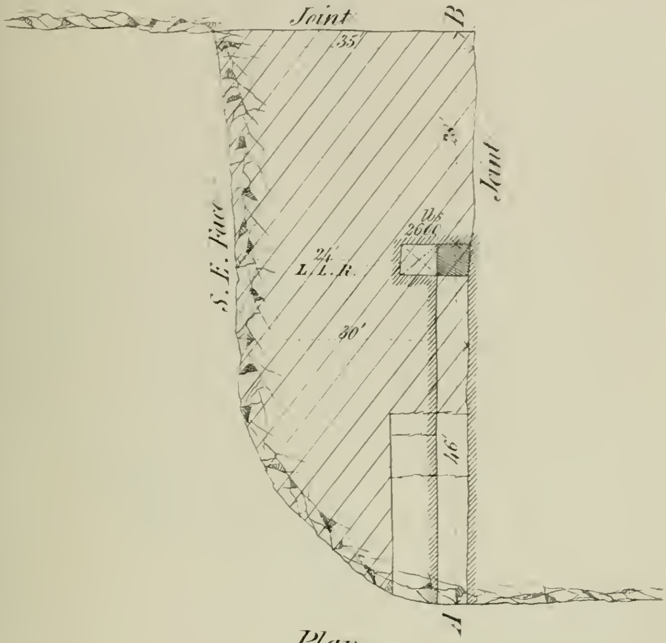
Section on A B.

Note The part shaded represents the Masses probably removed, the state of the Lower part of the Crater not being determinable until after the Debris is removed.

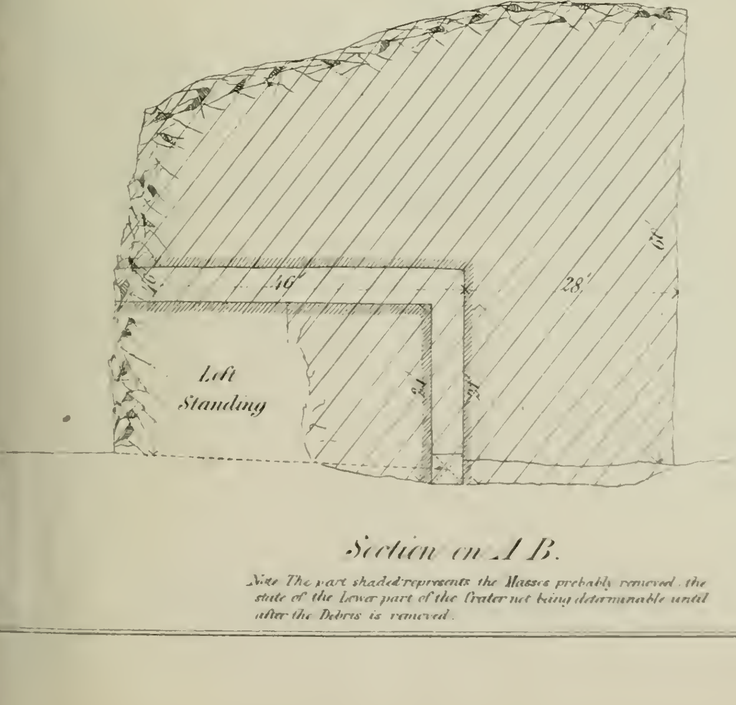
MINE Nº 56. QUARRY Nº 3.

Fired 23rd July 1851.

Scale, 1 Inch = 25 feet.



Plan

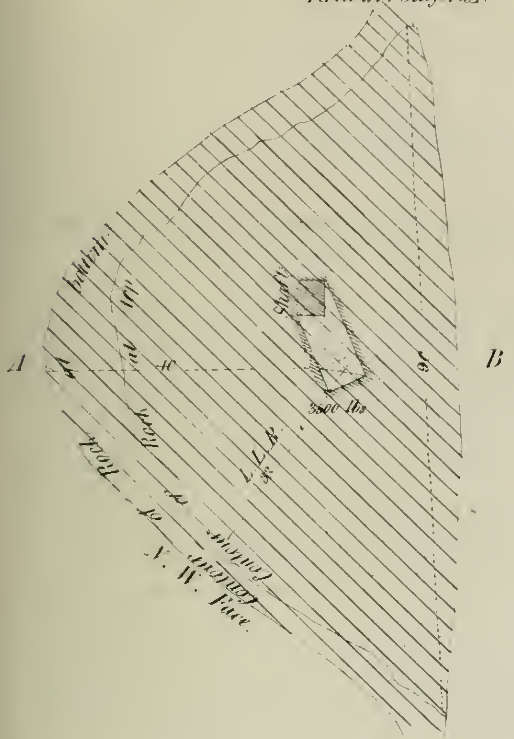


Section on A B.

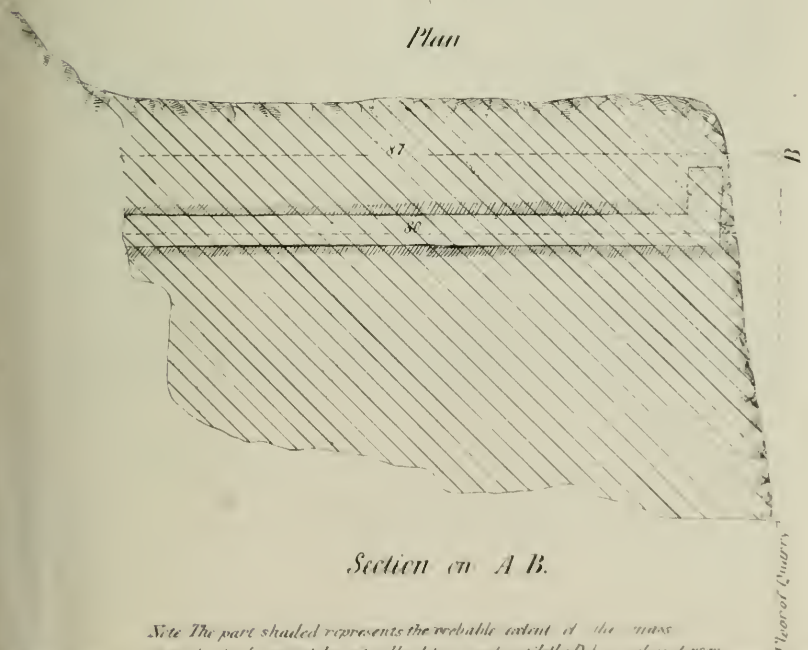
Note The part shaded represents the Masses probably removed, the state of the lower part of the Crater not being determinable until after the Debris is removed.

MINE Nº 57. QUARRY Nº 6.

Fired 24th July 1851.



Plan



Section on A B.

Note The part shaded represents the probable extent of the mass removed which cannot be actually determined until the Debris is cleared away

PAPER II.

DESCRIPTION of a MILITARY CHAPEL, built for part of the GARRISON of DUBLIN. By Major-General G. G. LEWIS, C.B.R.E.

THE drawings which accompany this paper will explain the design of a Military Chapel erected for a part of the Garrison of Dublin, 1846–7, and made under my direction, by Mr. Cumming, Assistant Surveyor in the Royal Engineer Office of the Chief Engineer in Ireland. The plan had two objects; providing a Chapel for the Military Prisoners in the Prison adjoining, and for two Regiments of Infantry and one of Cavalry, in the Royal Barracks, also near it. The building provided seats for 1608 persons, and the cost was about two pounds per sitting.

The architecture, externally, was taken from a church lately built in the west of England, and the peculiarity that recommended the design to me was, the position of the stairs, which are placed outside of the body of the building, and thus the noise of ascending and descending was in a great measure removed (see Plan No. 7).

The general arrangement of the sittings was in reference to the nature of the congregation, and consequent separation of rank and sexes (see Plan No. 1), which renders the construction of a military chapel necessarily different from ordinary Protestant churches divided into pews, and where, in fact, economy in space is essential as well as of arrangement. The disposition of the whole was satisfactory; and I have a communication by me from the Garrison Chaplain, wherein he states that, as regards the hearing, every word is distinctly heard in every part; and the chapel is considered by several clergymen of the diocese as most comfortable and well appointed*.

The following specification will explain, with the Plans from 1 to 8 inclusive, the nature of the work, and the details. The walls of the chapel are built of rubble masonry and lime-stone, in regular courses, with granite ornaments, as shown in articles 9, 11, 12, 15, 17, and 18 of the Specification. The roof is of fir, and the galleries, floors, &c., of deal, supported by cast-iron columns; the sash frames are of cast iron; and the ceilings and roof are painted in imitation of oak.

This description of a military chapel, I believe, is the only one given in the Professional Volumes; and as the building answers every purpose proposed, it is conceived that the drawings may serve to assist the Corps in designs of a similar nature.

G. G. L.

August, 1851.

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* See note at the end of this Paper.

SPECIFICATIONS for the ERECTION of a MILITARY CHAPEL, DUBLIN.

CHAPEL—EXCAVATOR.

Foundations, &c. 1. The ground to be dug and thrown out to the required depths, and to such additional depths as may be required for the foundations and other purposes.

2. The bottoms of the excavations to be well beaten down, as before described.

Filling. 3. After the masonry of the footings has been built in, the remaining spaces of the trenches are to be filled and well rammed to the finished ground-line.

Disposal of surplus earth, &c. 4. The superfluous earth and rubbish to be removed, spread, and levelled, as shall be directed, and such as may not be required in the formation of the ground, to be removed off the Ordnance premises.

MASON, BRICKLAYER, AND STONE-CUTTER.

Concrete. 5. Concrete, as before described, to be laid to the required lengths, breadths, and depths, as footings for the steps.

Drains. 6. Two twelve-inch barrel-drains of brickwork in cement, to be constructed for the discharge of the waste water from the premises into the main sewers.

Foundations. 7. The foundations, and dwarf and fender walls, to be of rubble masonry in mortar, as before described, and of the depths and the thicknesses shown in the drawings.

8. Killaloe rag ton slates, bedded in cement, to be laid on the walls at the height of six inches over the ground-line.

Superstructure. 9. The superstructure to be of rubble hammer-dressed masonry, with horizontal beds, and vertical joints on the outer face.

Ventilation under floors. 10. Flues to be formed, as shown in the drawings, for the ventilation of the floors, and fitted with iron gratings.

Steps. 11. All the door-steps, stairs, and landings, to be of chiselled granite set in mortar, the stairs and landings having nine-inch bearings on the walls.

Stone dressings, &c. 12. The external arches, hood mouldings, door and window jambs, heads, sills, mullions and tracery, screen-work to stairs, corbels under ends of girders of flat roofs, ends of gallery-trusses, springing of principal roof, water-tables of buttresses, cornices and blocks to eaves and gables, copings or verge courses, blockings to parapet copings, circular turret and eaves courses, to be of chiselled, sunk, moulded, and weathered granite, set in mortar and pointed in cement, as shown on the drawings.

Quoins. 13. The quoins of buttresses, and other external angles, not otherwise shown, to be cut to the vertical line.

Chamfers. 14. All chamfers to be sunk and finished as chiselled work.

Roofs of square turrets. 15. The roofs of square turrets to be formed of four-inch granite flagging, chiselled on the face, rebated at the joints, and run with lead.

Circular turret. 16. The lower part of the circular turret to be of masonry, as before described; for the face of the building, curved on the face.

Blank heads to doors and windows. 17. The blank heads to doors and to the windows on either side of porch, to be formed of four-inch chiselled granite landings, sunk as shown on the soffitte, and the two blank windows over the same in front to be similarly fitted.

Templates under iron columns. 18. Templates of granite two feet square and one foot thick to be fixed on footings of masonry in mortar, to receive the feet of the iron columns of the pulpit and gallery.

19. The floors of the porch, lower floors of turrets, side entrances, under transept stairs, and in the several doorways leading from the porches, turrets, and entrances into the chapel, to be laid with asphalte of Seysel on beds of concrete not less than six inches deep.

teps. 20. Wherever door-frames are provided, the stone door-steps are to be morticed to receive the iron tenons of the wooden frames.

crapers. 21. Mortices to be sunk for fixing two iron door-scrapers at each external doorway.

iron work. 22. Proper sinkings to be made for fixing all the necessary iron work, hooks, hinges, pivots, &c., cramps, dowels, &c., for fixing and securing the stone work.

to drains. 23. Two shafts of nine-inch brickwork in cement, and twelve inches square, to be formed in connection with the sewers for the discharge of surface water, fitted with iron gratings secured to chiselled perforated and rebated solid granite curbs six inches thick, bedded in cement.

e drains. 24. The surface-drains to be formed all round, and to the distance of eight feet from the building, of four bricks on edge in mortar, pointed with cement, and laid with a sufficient fall to carry off the surface water to the before-mentioned shafts.

aths. 25. The intervals between the surface-drains and the building, and to the extent of one foot outside the surface-drains, to be paved with assorted three-inch pebbles, laid as before described, and finished with granite street curb, five inches wide on the face, and not less than nine inches deep.

26. The remaining spaces of the chapel yard to be covered with powder paving, three inches deep, and gravelled one inch thick.

CARPENTER AND JOINER.

ng. ipal roof. 27. The roofs throughout to be of fir, wrought, framed, and chamfered; tie-beams, twelve inches by six inches; queen-posts, ten inches and a quarter by six inches, and seven inches by six inches in the waist; principal rafters, eight inches and a half by six inches; straining-beams, eight inches and a half by six inches; struts, three inches and a quarter by six inches; straining-sills, four inches and a quarter by six inches; struts above straining-beams, six inches by six inches; purlins, seven inches by four inches; pole-plates, four inches and a half by four inches; wall-plate, eight inches and three-quarters by five inches; wall-pieces behind braces under tie-beams, eight inches by six inches; curved braces, eight inches by six inches; ditto, above straining-beams, six inches by six inches; tracery, four inches by three inches, with two curved pendents to each tie-beam.

s of tran- 28. Tie-beams, ten inches by four inches and a half; queen-posts, eight inches by four inches and a half; struts, two inches by four inches and a half; ditto, above the straining-beams, four inches by four inches and a half; principal rafters, five inches by four inches and a half; straining-beams, six inches and a half by four inches and a half; straining-sills, three inches by four inches and a half; purlins, seven inches by four inches; pole-plates, four inches and a quarter by four inches; curved braces, six inches by four and a half inches; tracery, three inches by three inches; wall-plates, six inches by four inches; and wall-pieces behind braces under tie-beams, six inches by four inches and a half, with two curved pendents to each tie-beam.

inuation of ept roofs over nain roof. 29. Purlins and hip-plates, seven inches by four inches; and struts, four inches by four inches.

Chancel roof. 30. Pole-plates, four inches by four inches; and purlins, eight inches by four inches.

Porch roofs. 31. Pole-plates, four inches by four inches; and purlins, seven inches by four inches.

Flat roofs over officers' entrance and vestry. 32. Joists, eight inches by two inches, one foot from centre to centre; and wall-plates, four inches by three inches.

Roof boarding. 33. All the roofs to be covered, one-inch deal wrought one side, and shot, and rough where not seen from the interior of the chapel.

Staircase roofs. 34. Two-inch deal wrought on the under side, shot and fillistered, and laid on fir girders, ten inches by six inches, wrought, chamfered, and fixed as shown on the drawings.

Bell-turret roof. 35. Fir pole-plate, five inches by four inches; collars, four inches by three inches; ridge-post, six inches by six inches; principal rafters, four inches by three inches; intermediate rafters, four inches by two inches; and braces, four inches by two inches.

Centering. 36. Proper centering to be provided, fixed, eased, removed, and refixed as may be required.

Door-frames. 37. Fir door-frames to all doorways, six inches by five inches, wrought, framed, rebated, and chamfered, the feet of them secured to the door steps, with cast-iron tenons, the head built into the masonry, and the jambs fastened by iron screw-bolts, let into the reveal.

Lintels. 38. Fir lintels, where required, of the respective widths of the work they may have to support, one inch thick for every foot in length, and having nine inches bearing on the jambs.

Floors. 39. The joists of the body of the chapel, transepts, and chancel, officers' entrance and vestry, to be of fir, six inches by two inches, placed one foot from centre to centre on plates of fir, four inches by three inches.

40. The upper floor of bell-turret to have a fir curb, or wall-plate, six inches by six inches, with two wrought and chamfered fir girders, ten inches by six inches, and bearers, ten inches by six inches, for the support of the bell.

41. The lower floor or landing in turret at top of gallery stairs to have wrought and chamfered girders, eleven inches by eight inches, and wall-plates six inches by four inches.

Trusses, &c., to galleries. 42. The transept galleries to have fir breast-summers, twelve inches by nine inches, wrought, framed, and chamfered, fixed on cast-iron columns.

43. The trusses for the support of the floors also of fir, wrought, framed, and chamfered; tie-beams, twelve inches by nine inches; principals, nine inches by nine inches; posts and struts, nine inches by nine inches; templates, six inches by six inches; binding-joists, eight inches by four inches; and bridging-joists notched on the same, four inches by two inches, and fixed twelve inches from centre to centre.

44. The children's gallery to have wrought, framed, and chamfered, fir breast-summer, twelve inches by nine inches; tie-beams, twelve inches by seven inches; principals, seven inches by seven inches; posts and struts, seven inches by seven inches; templates, six inches by six inches; binding-joists, eighteen inches by four inches; and bridging-joists, four inches by two inches, and fixed twelve inches from centre to centre.

45. Band-gallery to have wrought and chamfered breast-summer, twelve inches by nine inches; tie-beams, twelve inches by four inches; principals, five inches by four inches; and posts, four inches by four inches; templates, six inches by

six inches; binding-joists, eight inches by four inches; and bridging-joists, four inches by two inches, placed twelve inches from centre to centre.

g-joists to es.

46. Fir ceiling-joists three inches by two inches, fixed twelve inches from centre to centre, notched and nailed to the under edges of the gallery binding-joists.

y fronts.

47. The gallery fronts to be formed of wrought, framed, and chamfered fir sills, four inches by four inches; top rails, four inches by four inches; mullions with circular heads, three inches by three inches, all rebated to receive one-inch deal boarding, wrought both sides, ploughed and tongued. The joint between the breast-summers and sills to be covered by a moulding of eight-inch girth, and the top rail to be finished with a moulded capping seven inches by four inches, sunk to fit down upon the top rails.

ing of bell-

48. The upper floor of bell-turret to be laid with one-inch and a half deal flooring, wrought on the under side and laid with straight joints, with a trap-door three feet square, as shown on the drawings.

49. The lower floors, or landings in turrets at head of gallery stairs, to be laid with two-inch deal, wrought both sides, ploughed, and tongued.

ing in the
of the cha-
&c.

50. The floors of the body of the chapel, the transepts, officers' entrance, and vestry, to be laid with one-inch and a half deal, wrought, shot, rebated, filletted, and straight jointed, with tongued headings.

steps.

51. Steps at altar to be formed of one-inch and a half deal, wrought one side and shot, with rounded nosings and fir bracketted; carriages four inches by three inches.

ing of tran-
galleries.

52. The flooring of the galleries in the transepts to be of one-inch and a half deal, shot and fillistered, with rounded nosings; the risers to be of one-inch deal, wrought one side and shot.

ren's and
-galleries.

53. The flooring to be the same in all respects as for the transept-galleries.

s to the band-
ry.

54. Stairs to band-gallery to have one-inch and a half deal steps and risers, wrought and mitred with rounded and returned nosings; one-inch and a half deal wall-string, wrought and housed, for steps and risers; face-string of one-inch and a half deal, wrought, cut, and mitred, for steps and risers, framed to wrought and chamfered fir newels, three inches by three inches, with oak, wrought, sunk, and moulded hand-rail, three inches by three inches, and one-inch and a quarter deal square balusters, dovetailed to the steps and housed into the hand-rails; four iron balusters to be provided and fixed, to match the wooden ones, and to secure the hand-rails.

55. The stairs to be supported on fir carriages, six inches by three inches, three to each flight, fixed to fir-framed trimmers nine inches by three inches, and with one-inch and a half rough deal brackets.

56. Joists of the quarter spaces and landings to be of fir, four inches by two inches, twelve inches from centre to centre on plates four inches by two inches, laid with one-inch and a half deal, wrought and fillistered flooring; one-inch and a quarter deal skirting, nine inches wide, to be made good to the wall-string, and plugged to the walls with oak plugs.

rtings to body
hurch.

57. The skirting to the body of the chapel, transepts, chancel, officers' entrance, and vestry, to be of one-inch and a quarter deal, nine inches wide, wrought and chamfered, fixed to deal fillets two inches by one inch, plugged to the walls with oak plugs.

ncel railing.

58. The railing on the top step of the chancel to be formed of wrought,

framed, and chamfered sill, three inches by three inches; top rail three inches by three inches, mullions three inches by three inches, and capping five inches by three inches, to match the gallery fronts, having a portion in the centre, to the extent of five feet and a half, to open on hinges and hung folding.

Doors.

59. All the doors to be of two-inch and a half deal wrought, framed, braced, filled in with one-inch and a quarter deal sheeting, in widths not exceeding seven inches, wrought, rebated, and beaded, and back sheeted with the same diagonally; the doors to be hung folding, the external ones with wrought-iron hook-and-eye hinges, spanning the whole breadth of the doors, and the internal doors with three six-inch cast-iron butt hinges to each leaf.

60. The standing halves of the internal doors to be secured with ten-inch iron bright barrel-bolts, and those of the external doors with twelve-inch iron bright barrel-bolts.

61. The internal doors to have nine-inch iron rim drawback locks, with brass slide-plates and knob-handles on both sides.

62. The external doors to be fitted with strong ten-inch iron rim dead shot locks and large-size home-made thumb-latches.

63. All the external doors to be rivetted through, as shall be directed, with round-headed wrought-iron bolts, and the hinges to be made of ornamental patterns, as will be directed.

Pulpit and reading desk.

64. The pulpit and reading desk to be of one-inch and a quarter right Dutch wainscot, wrought both sides, framed, moulded one side, and fitted with one-inch and a quarter doors, hung with brass hinges and brass pulpit-latches; one-inch and a quarter deal, wrought and rebated flooring on fir, framed bearers, three inches by two inches; one-inch wainscot bookboards and bearers, wrought both sides, and wrought, moulded and sunk wainscot capping, to house down upon the framing; one-inch and a quarter wainscot seats, thirteen inches wide, on proper wrought, cut, and shaped brackets; one-inch wainscot steps and risers, with returned moulded nosings; one-inch and a quarter wainscot, wrought, beaded, sunk, and cut string boards, and strong bracketted carriages, with wainscot moulded and sunk hand-rails, turned and mitred caps, turned and dovetailed wainscot balusters, four wrought and turned iron balusters to match, together with all the appurtenances, fittings, and iron work, to complete the whole in a perfect, substantial, and handsome manner; together with the communion table, of right Dutch wainscot, with one-inch and a quarter top and sides, and turned legs, as will be directed, at an expense not exceeding sixty pounds sterling.

Seats.

65. The body of the chapel, transepts, and galleries, to be fitted with deal forms; the tops of an inch and a half deal, twelve inches wide, wrought both sides, and rounded at the ends, with wrought, cut, and shaped legs, twelve inches by one inch and a half; ledges, six inches by one inch and a half, and braces three inches by two inches. Those for the officers to have open backs of wrought and framed rails, and standards four inches by one inch and a half.

Kyanizing.

66. All the timber in door-frames, lintels, wood-bricks, templates, wall-plates, joists, trimmers, trimming-joists, ceiling-joists, roofing, gutter-boarding and slate-boarding, gutter-bearers, and flooring, to be Kyanized.

IRONFOUNDER AND SMITH.

ation under

67. Cast-iron plates, nine inches by six inches, half an inch thick, and closely perforated with holes half an inch in diameter, to be provided for the apertures in external walls, for ventilation, underneath the floor of the body of the chapel and transepts.

s, &c.

68. Wrought-iron cramps and dowels to be provided for securing the stone work where required, and run with lead.

s for door-

69. Cast-iron tenons, one inch and a half square, with plates half an inch thick, to be provided and fixed to the feet of the door frames, let into the stone work, and run with lead.

scrapers.

70. Two cast-iron door scrapers to be provided for each external doorway, let into the door-steps, and run with lead.

-gratings.

71. Wrought-iron gratings with steeled eyes, let into the stone curbs, and run with lead, as before described, to be provided and fixed over the shafts to sewers.

ng-irons.

72. All the trusses of the roofs to be fitted with stirrups of wrought iron, two inches by half an inch, one-inch square iron screw-bolts and nuts, and iron wedges half an inch thick.

work to gal-

73. The trusses to be fitted with wrought-iron stirrups, as before described, with one-inch square iron screw-bolts and nuts, and one-inch and a quarter round iron screw king-bolts and nuts.

nns for gal-

74. The galleries to be supported on cast-iron columns, of an average bore of eight inches, and five-eighths of an inch thick, with caps and bases, as shown in the drawing, the feet to be let into stone plinths, and run with lead.

ry fronts.

75. The gallery front framings to be secured with wrought-iron knees, two inches and a half wide and half an inch thick, neatly fixed with one-inch square iron screw-bolts and nuts.

front.

76. The framed inclosure of the altar to be secured similarly to that of the gallery fronts.

sters to gal-
stairs.

77. The hand-rails of gallery stairs to be secured with four one-inch and a quarter wrought-iron square balusters to match the wooden ones, and firmly screwed to the string-boards, steps, and hand-rails.

work to se-
door-jams.

78. Each of the door-frames to be fixed with not less than six three-quarter inch square iron screw-bolts and nuts, let into the stone reveals, and run with lead.

es.

79. All the sashes to be of cast iron, one inch and three-eighths thick, to be built into grooves cut in the stone work.

it.

80. A cast-iron column, to correspond with those for the galleries, to be provided and fixed to stone plinth below the floor, and run with lead, and to be fitted with wrought-iron plates, as shall be directed for securing it to the framework of the pulpit.

81. The stairs to be stiffened and secured with all necessary wrought-iron knees, as shall be directed, together with four turned wrought-iron balusters to match the woodens, and wrought-iron screw-bolts and nuts, &c., as may be found necessary for the perfect completion and security of the work, together with an iron rack for raising the book-boards.

tters and
nks.

82. Five-inch semicircular cast-iron gutters, with fifteen stacks of three inches bore, cast-iron rain water pipes, cistern heads, perforated cover and shoes complete, as before described, to be provided and fixed as shall be directed.

BELL-FOUNDER.

83. One bell, of not less than four hundred weight, to be hung in the belfry, with all the necessary iron work, axle, wheel, tackle, and rope complete.

PLUMBER.

Turret.

84. The apex of the belfry turret-roof to be covered with sheet lead, eight pounds to the superficial foot, and the floor of the belfry with sheet lead, seven pounds to the foot, turned up and trimmed to the curb of the trap-door in the centre of the floor, and having flashings of lead, five pounds to the foot, and twelve inches wide, against the walls.

Staircase, vestry, and officers' entrance roofs.

85. These roofs or flats to be covered with sheet lead, eight pounds to the foot, and flashings, five pounds to the foot, as before described; the flats to be laid with a proper fall to the heads of the rain-water pipes, into which the water is to be discharged by three-inch bore lead pipes, two feet and a half long, and weighing sixteen pounds to the foot, properly fitted and soldered to the lead flats.

Gutters.

86. At the intersections of the turrets with the main roofs, gutters are to be laid with sheet lead, seven pounds to the foot, and flashings, five pounds to the foot, as before described.

Flashings and steps.

87. Flashings and step-flashings, not less than twelve inches wide, of five pounds sheet lead, to be fixed to all the gables throughout, and wherever otherwise required at the junctions of the roofs with the walls.

SLATER.

Roofs.

89. The roofs over body of the chapel, the transepts, chancel, and porch, and conical roof of the bell-turret, to be covered with Killaloe queen ton slates, laid on boards, with iron nails, dipped in oil, or painted, and with three-inch laps; the ridges to be covered with English white ridge-stone, bedded in mortar, and pointed with cement.

PLASTERER.

Ceilings.

90. The ceilings of the officers' entrance, the vestry, and underneath the galleries, to be lathed, plastered, floated, and set with fine stuff, and finished with two coats of whiting and size.

Walls.

91. All the walls of chapel, transepts, chancel, officers' entrance, vestry, porch, and turrets, with the several jambs, and arches of doorways, windows, and archways therein, to be rendered, floated, and set and finished with washed sand.

PAINTER AND GLAZIER.

Painting.

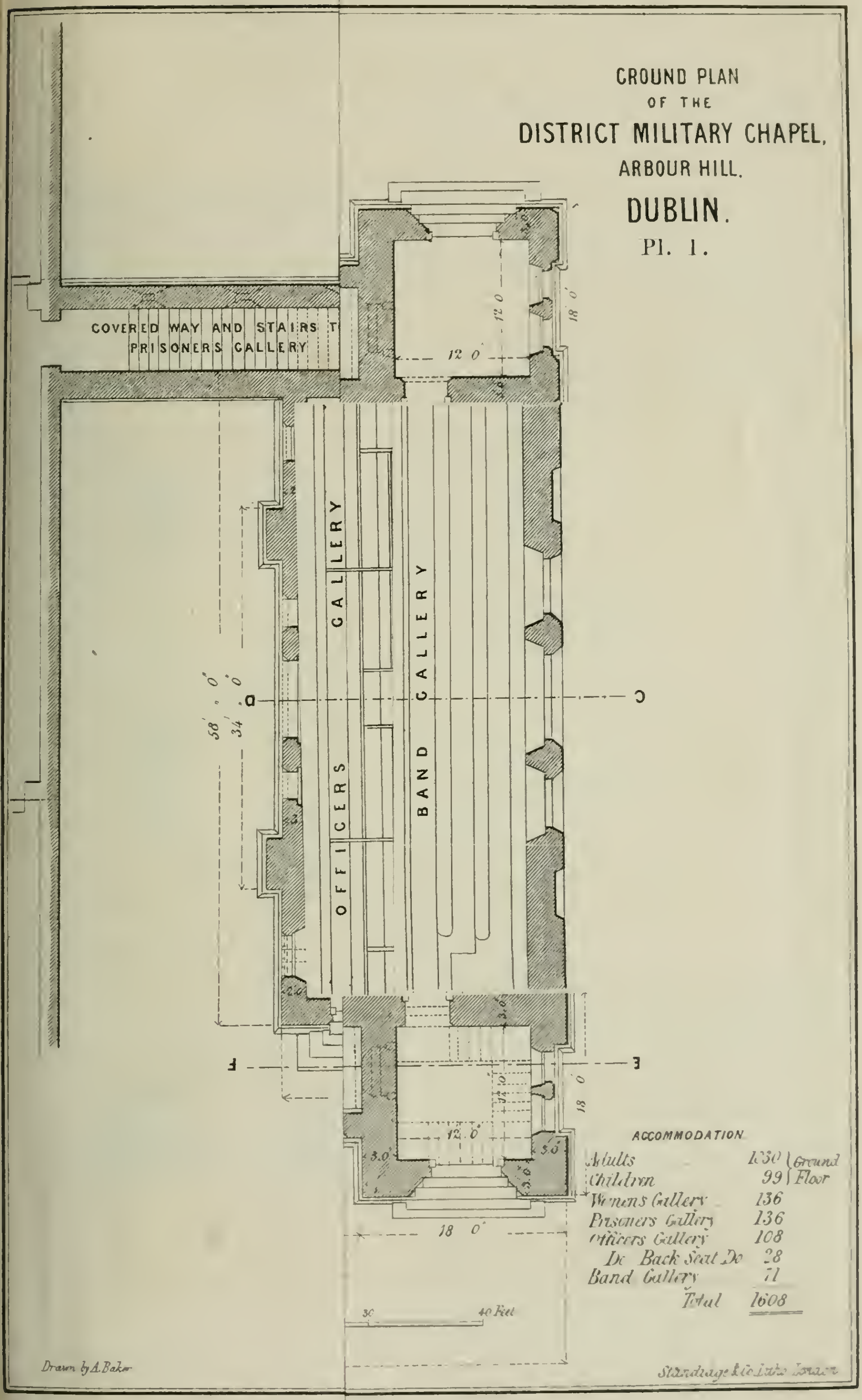
92. All the wood and iron work exposed to view, and such as is usually painted, to have four coats common colours, in oil, including all stopping, knotting, cleaning, and rubbing down.

Sashes.

93. All the sashes to be glazed with the best C glass.

NOTICE.

The contractor is hereby particularly required to observe, that the foregoing terms of contract, general regulations, and specifications, are intended to embrace all and every description and kind of labour, materials, and workmanship whatsoever, which may or shall be required for the due, full, and entire completion



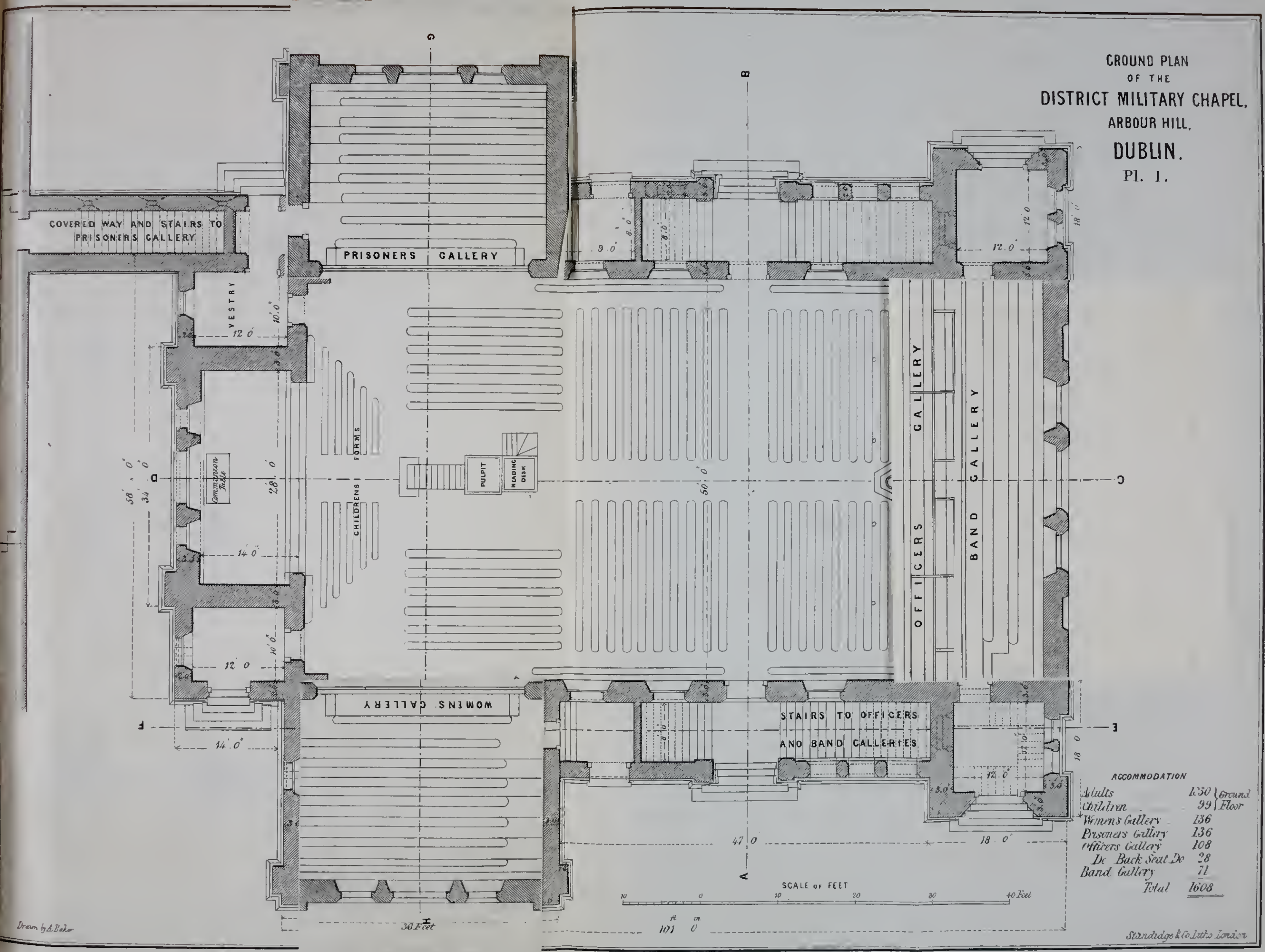
GROUND PLAN
OF THE
DISTRICT MILITARY CHAPEL,
ARBOUR HILL.
DUBLIN.
Pl. 1.

ACCOMMODATION

Adults	1030	Ground Floor
Children	99	
Womens Gallery	136	
Prisoners Gallery	136	
Officers Gallery	108	
Do Back Seat Do	28	
Band Gallery	71	
Total	1608	

Drawn by A. Baker

Standidge & Co Litho London



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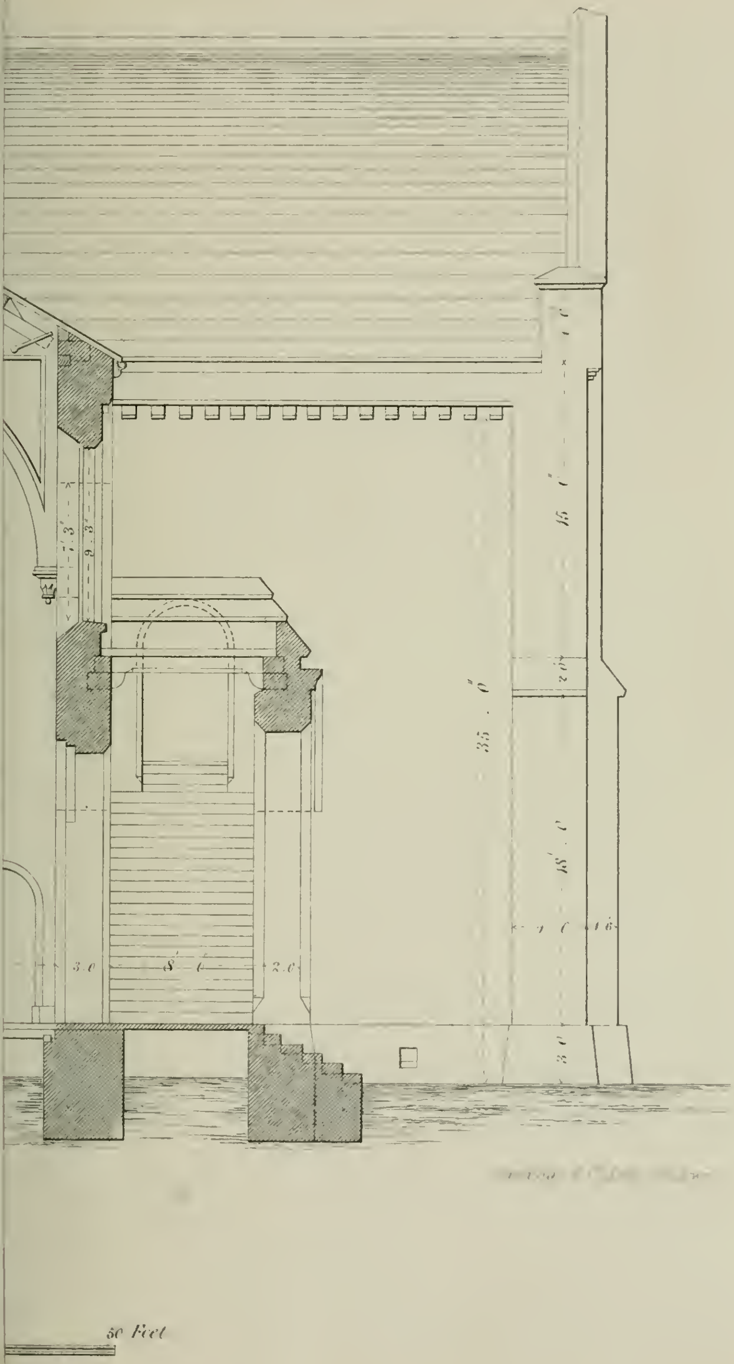
Pl. 2.



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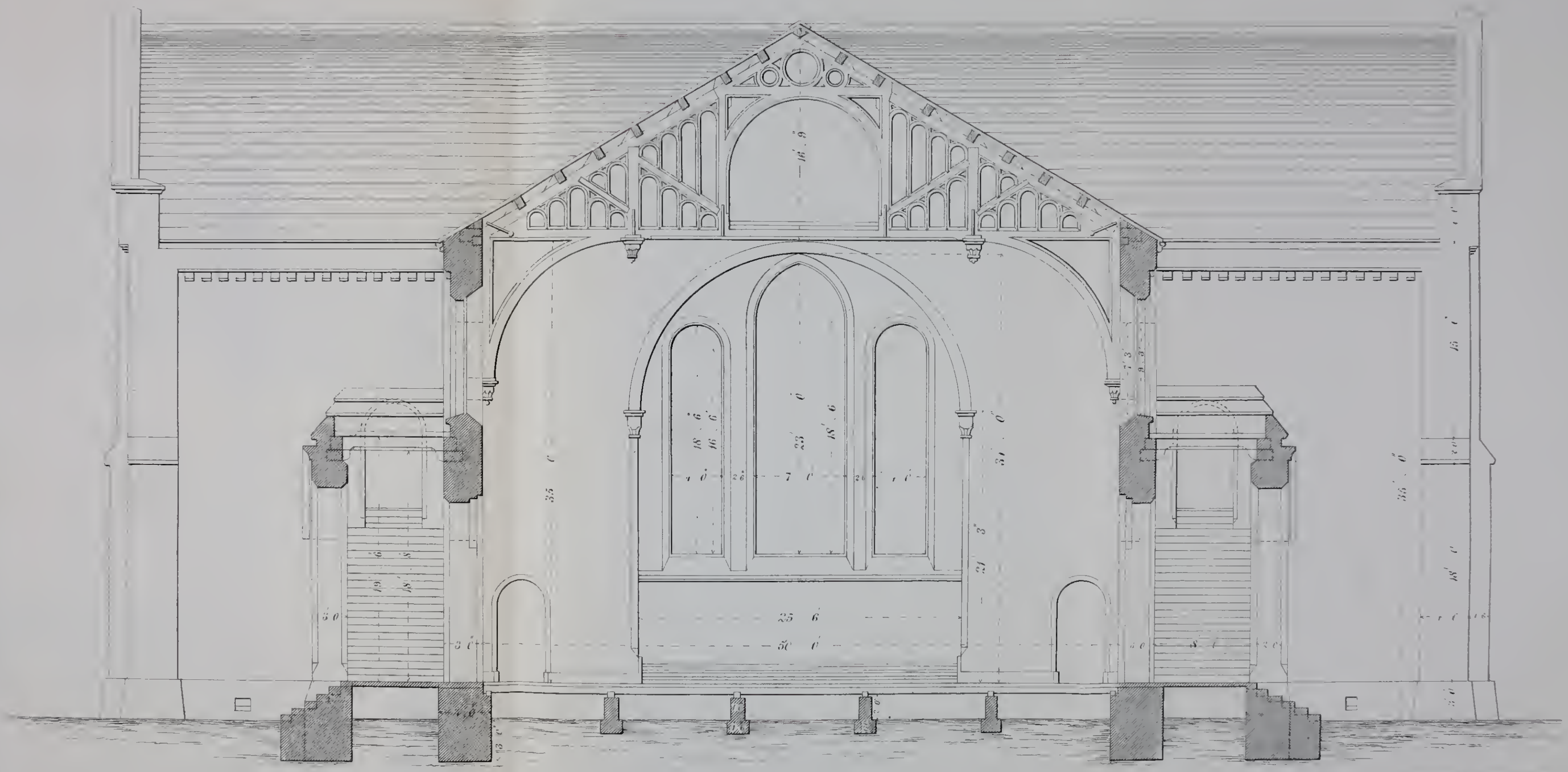
MILITARY CHAPEL, DUBLIN.

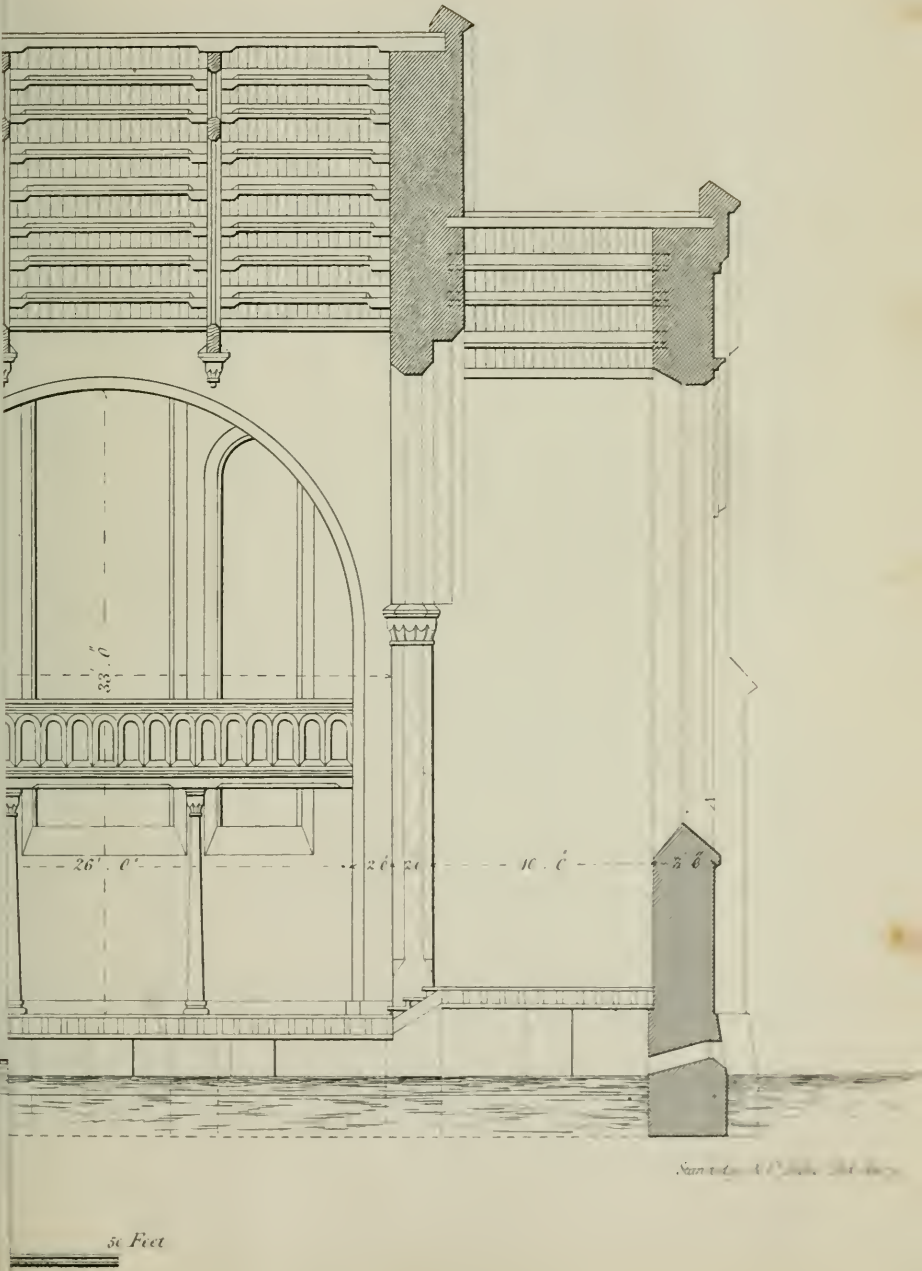


SECTION ON THE LINE A. B. ON PLAN.

Scale 10 Feet to an Inch.

10 5 0 10 20 30 40 50 Feet

Pl. 3.



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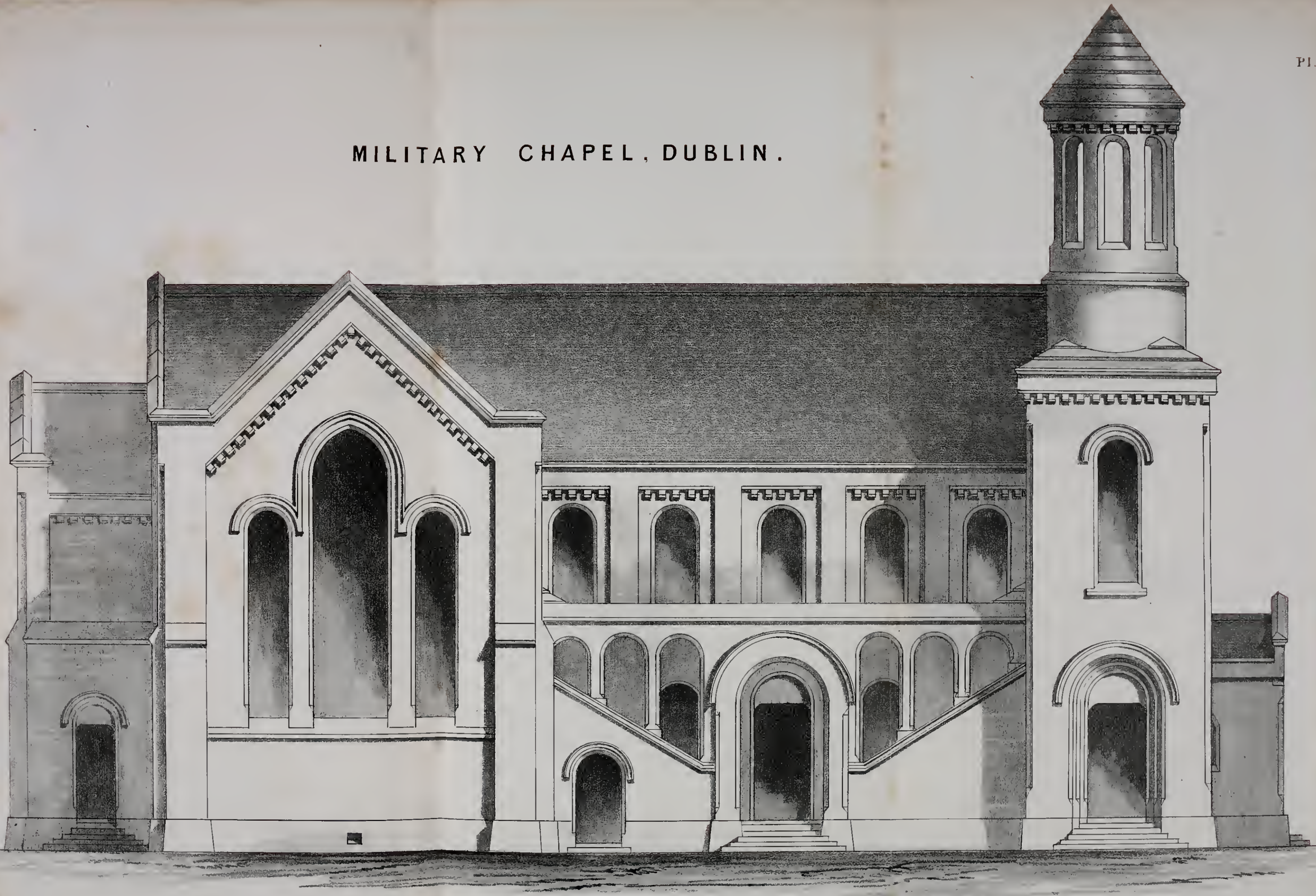
MILITARY CHAPEL, DUBLIN.

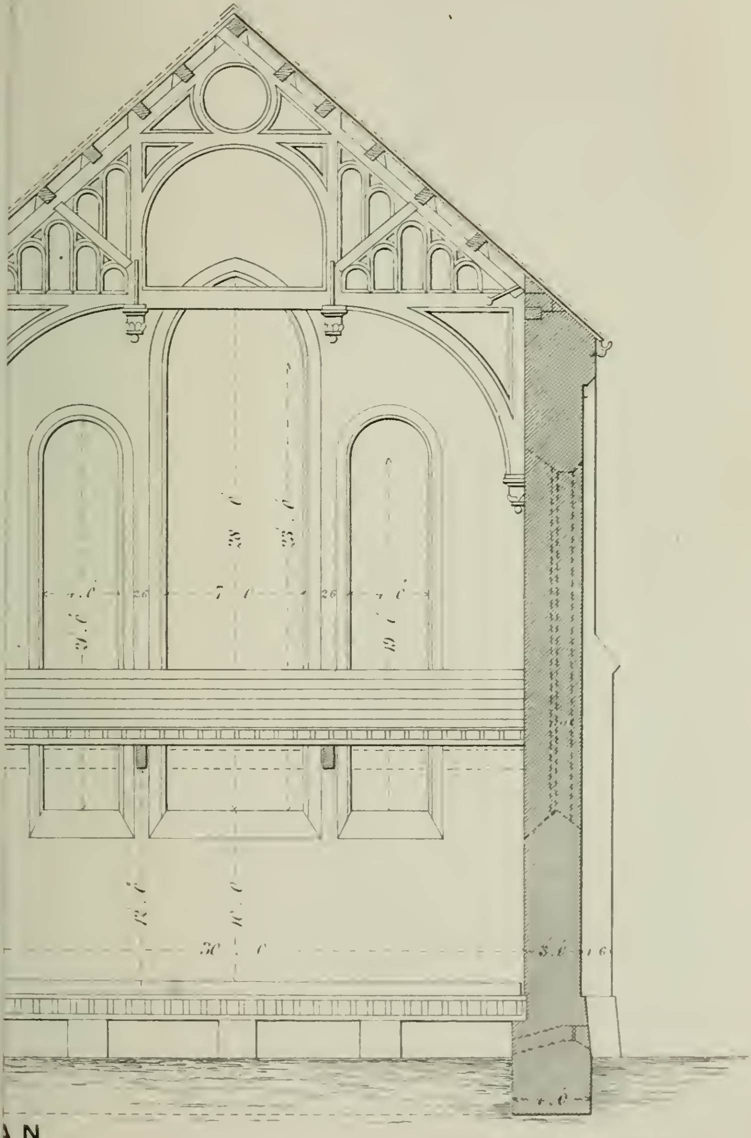


SIDE ELEVATION.

Scale 10 Feet to an Inch.

Standidge & Co. Litho Old Jewry.

Pl. 4.



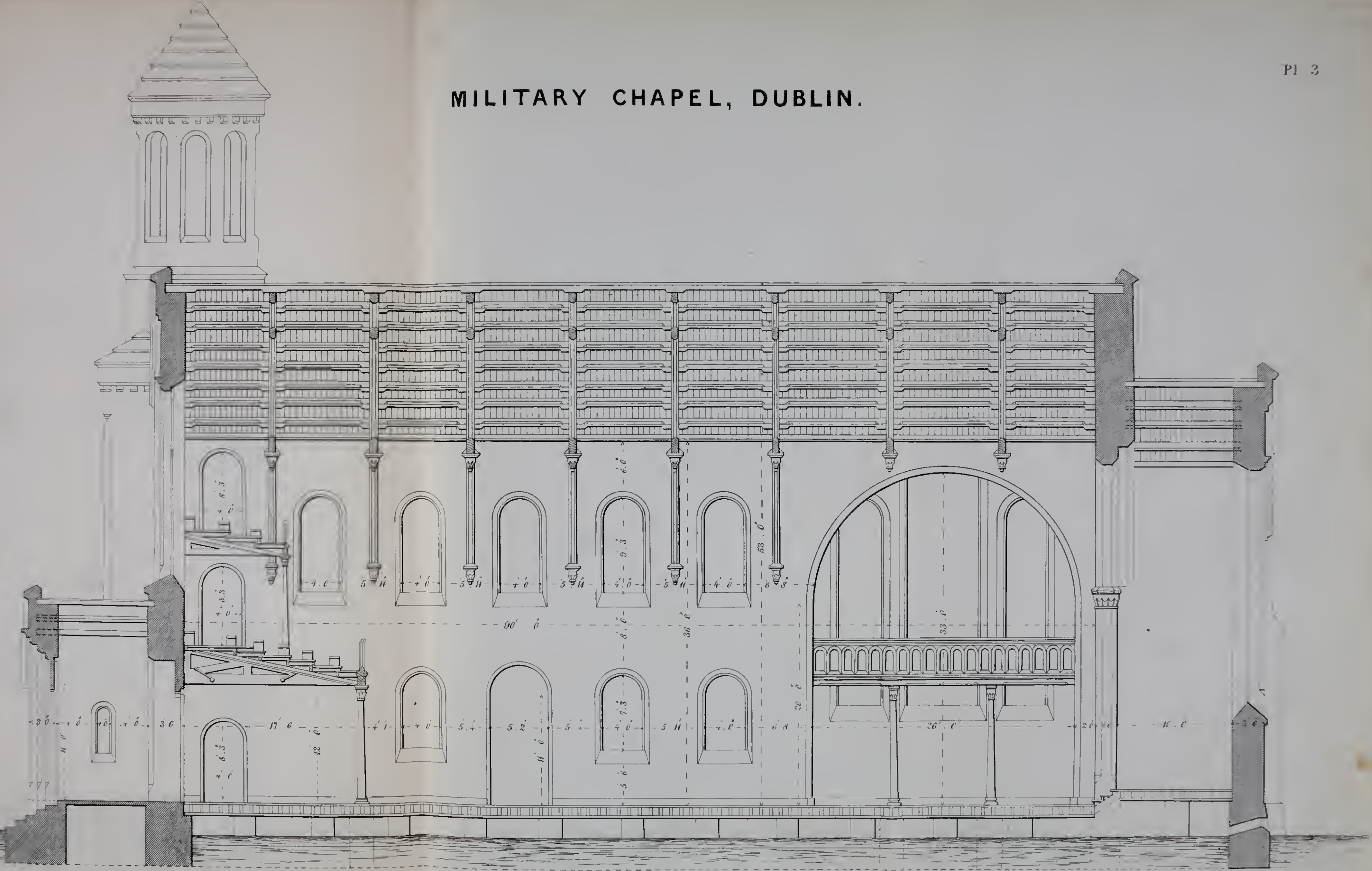
AN.

[illegible]

0 30 Feet

Pl 3

MILITARY CHAPEL, DUBLIN.

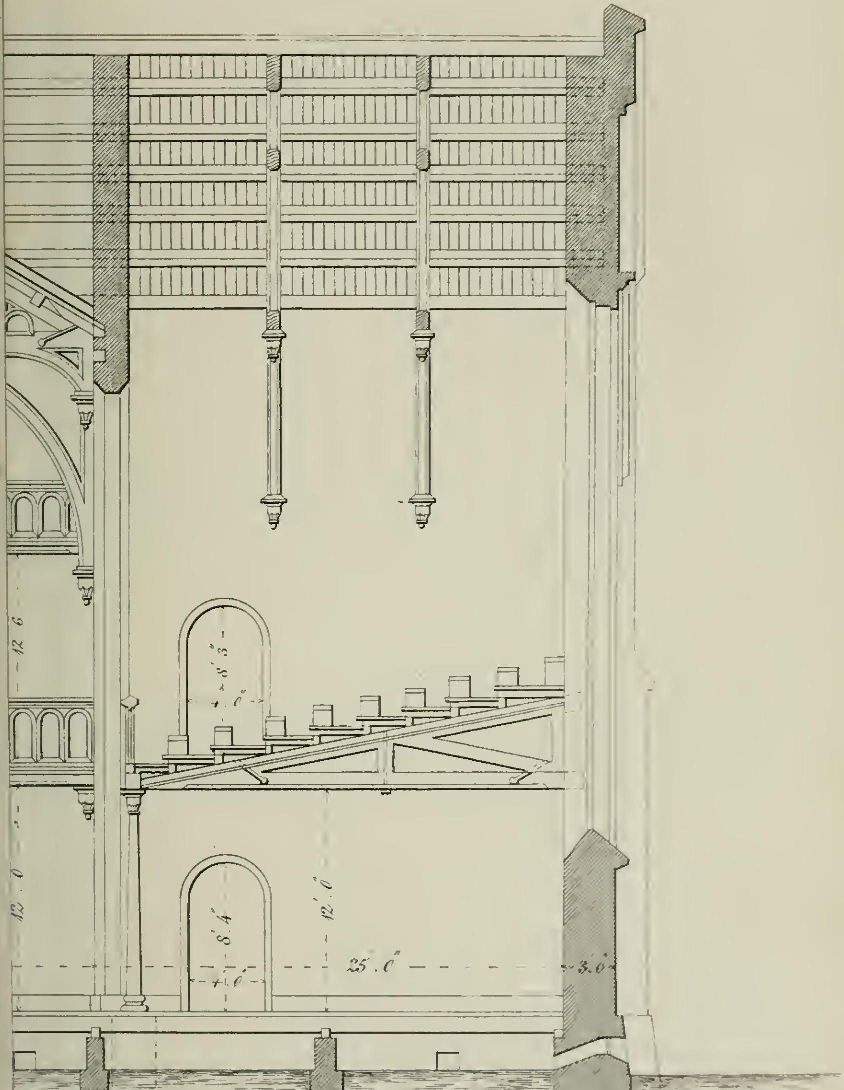


SECTION ON THE LINE C. D. ON PLAN.

Scale, 10 Feet to an Inch.

10 5 0 10 20 30 40 50 Feet

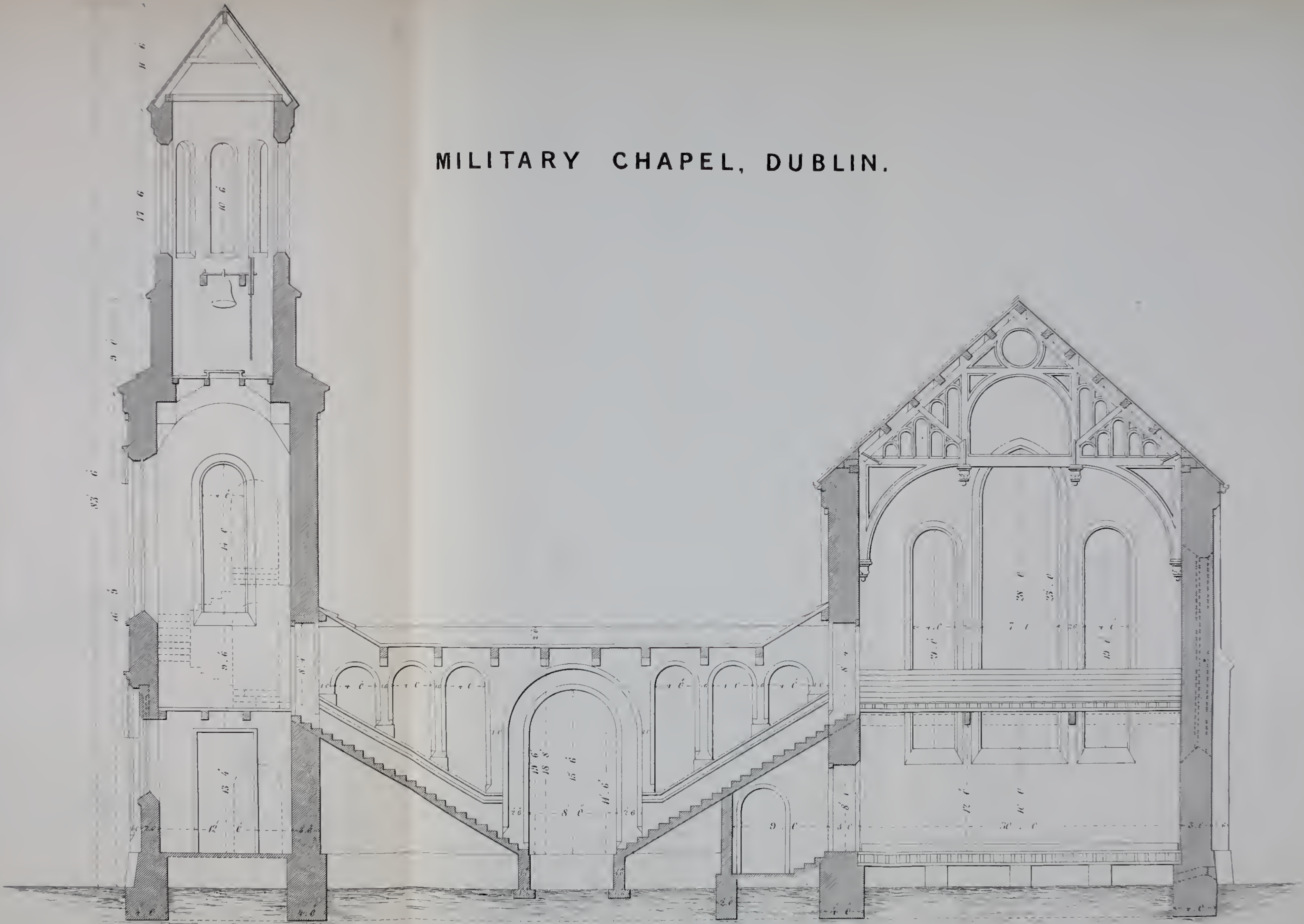
Pl. 5.



Standidge & Co Litho. Old Jewry

50 Feet

MILITARY CHAPEL, DUBLIN.

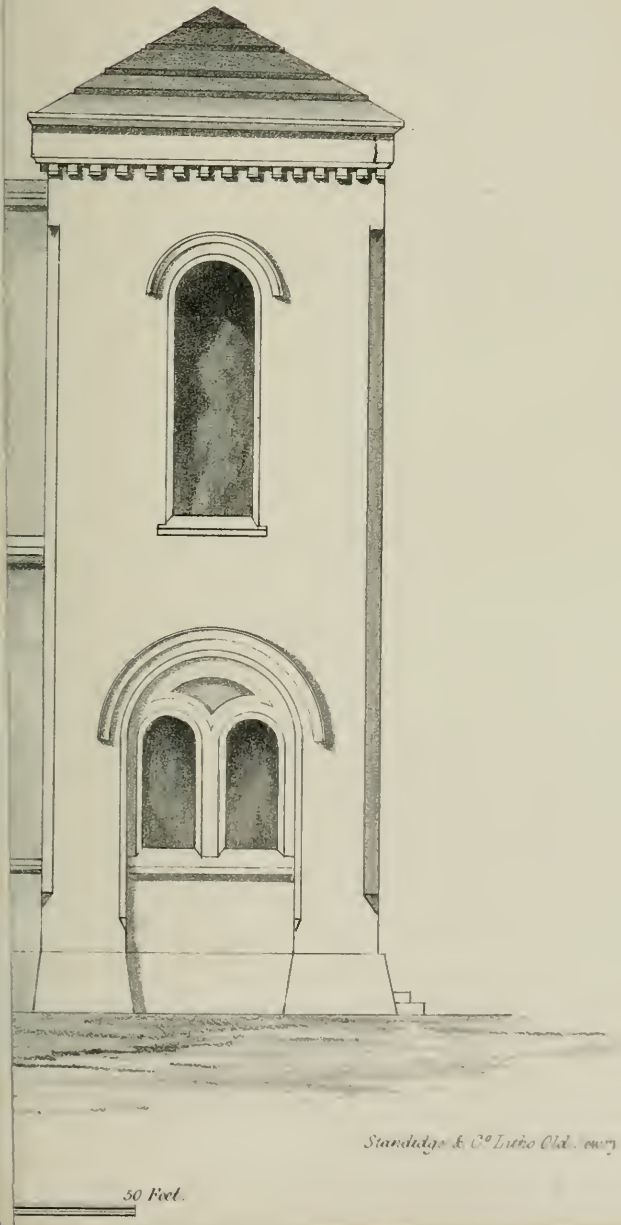


SECTION ON THE LINE E. F. ON PLAN.

Scale. 10 Feet to an Inch

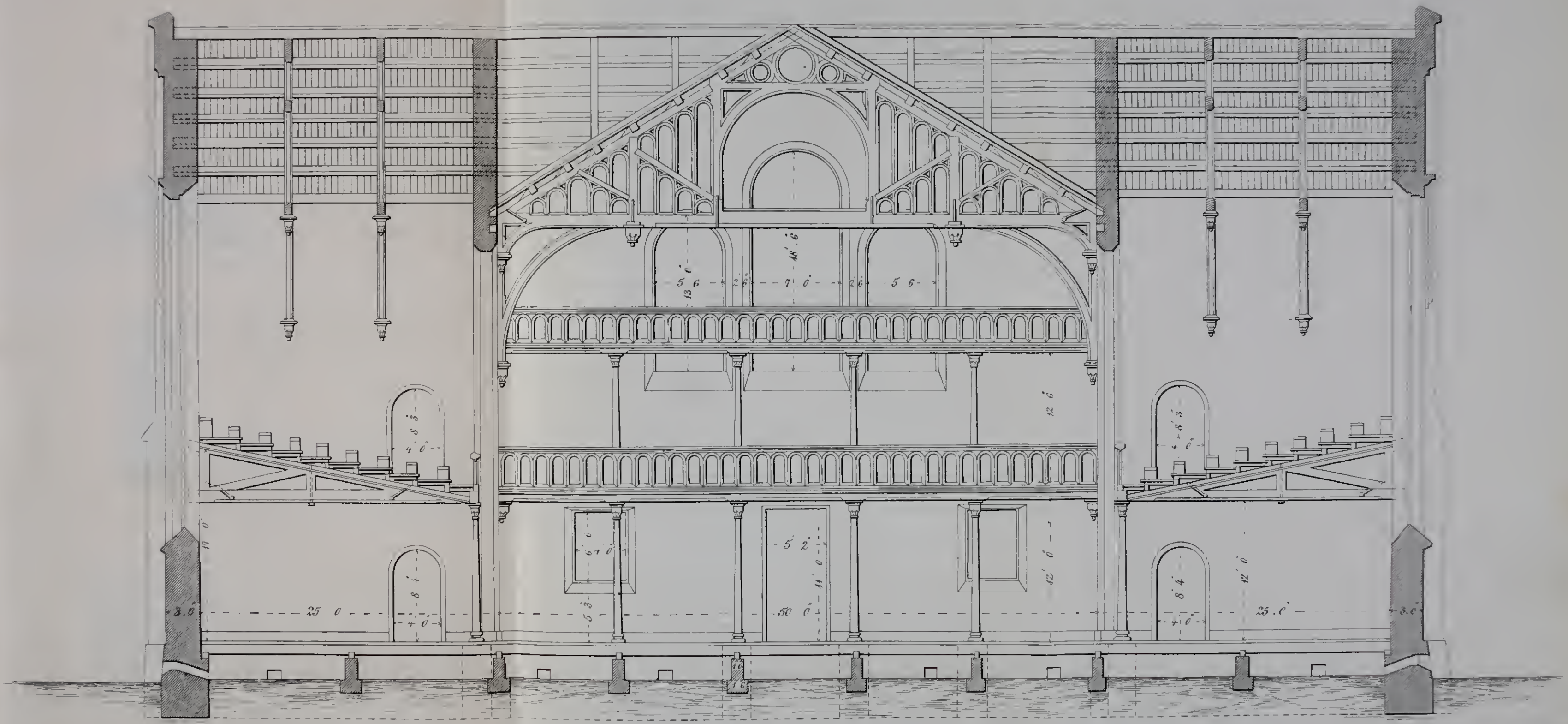
Pl. 6.

LIN.



Standidge & Co Litho Old Jewry.

MILITARY CHAPEL, DUBLIN.

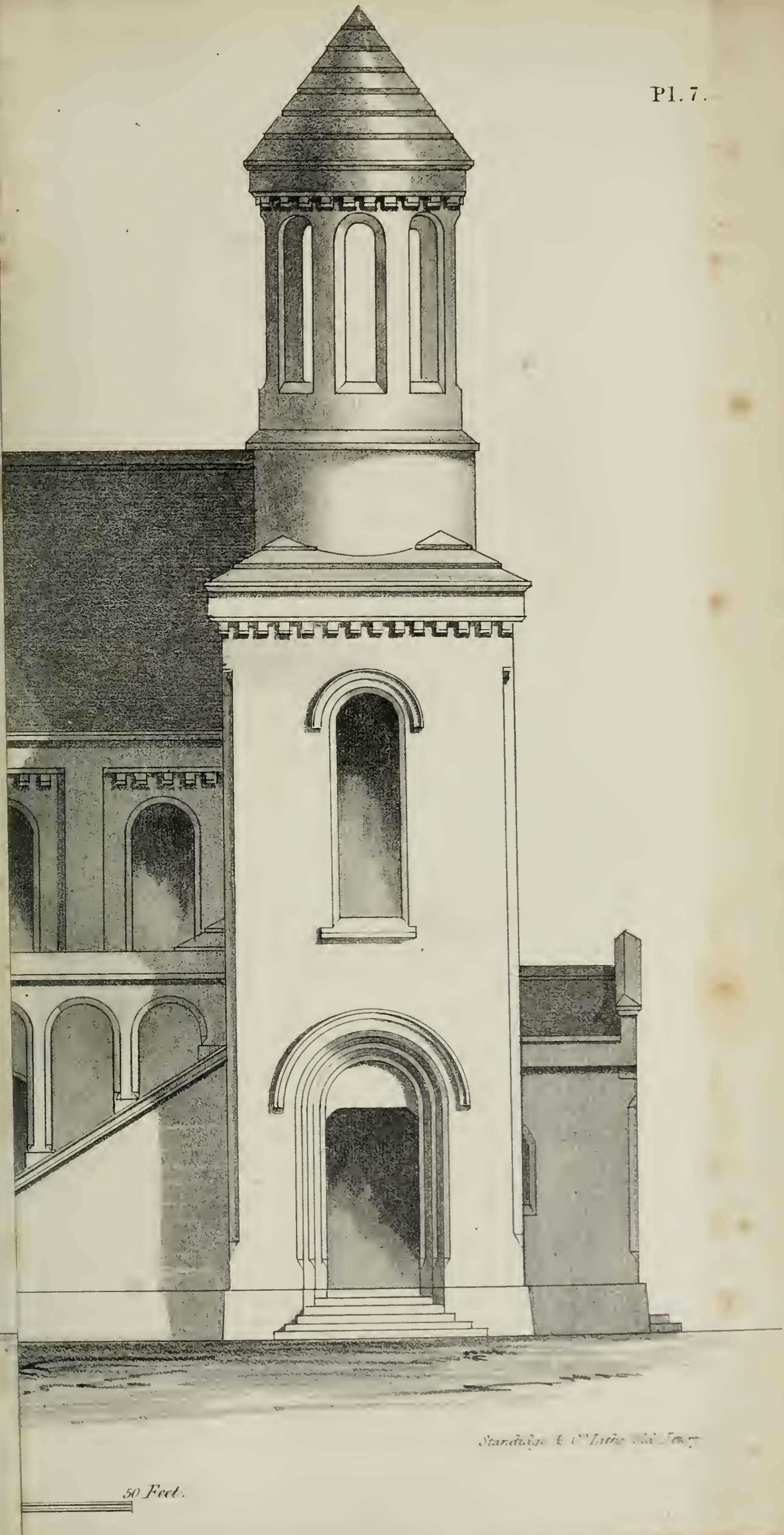


SECTION ON THE LINE G. H. ON PLAN.

Scale, 10 Feet to an Inch

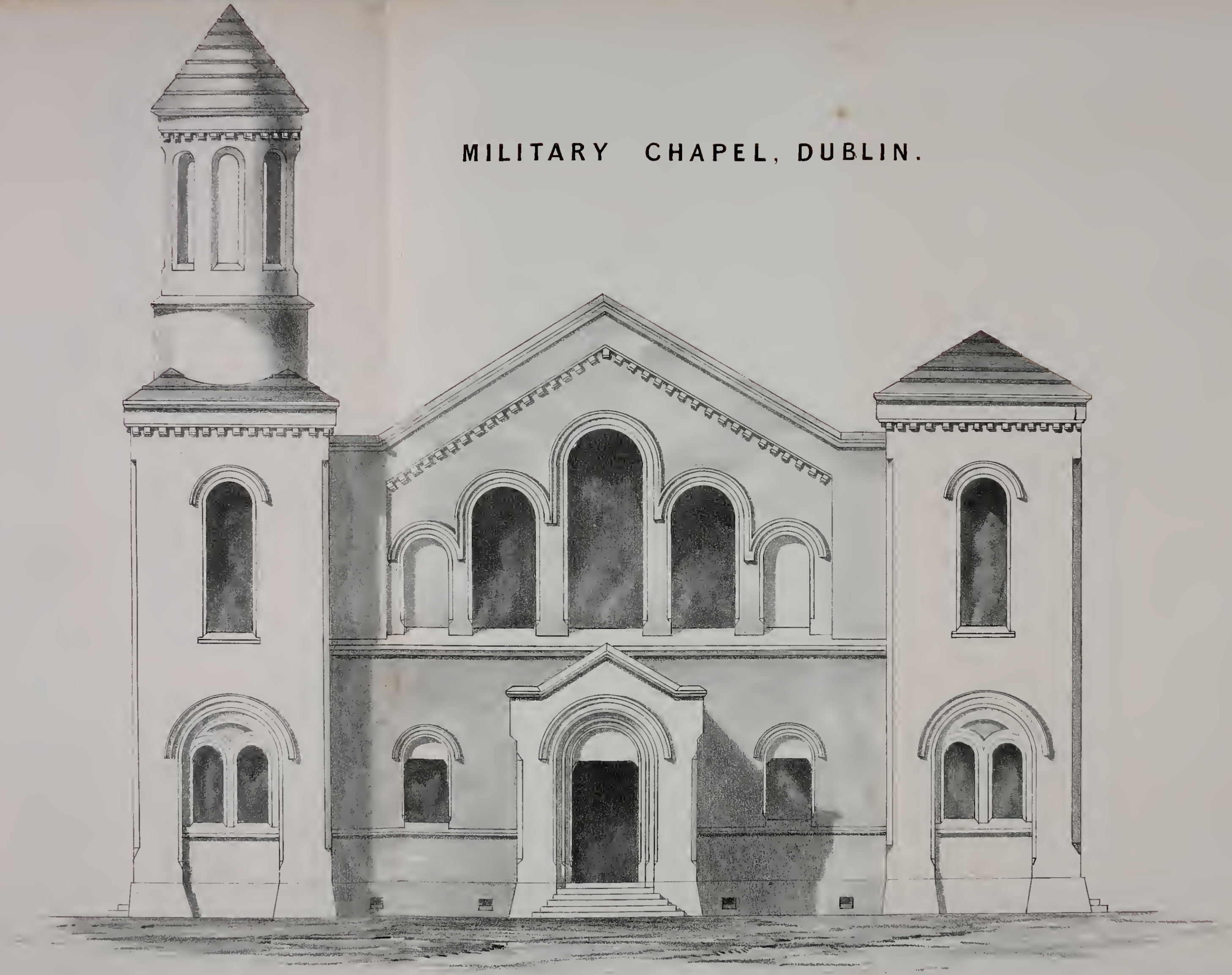
10 5 0 10 20 30 40 50 Feet

Pl. 7.



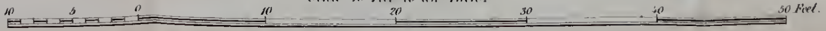
Standidge & Co Litho Old Jewry

MILITARY CHAPEL, DUBLIN.



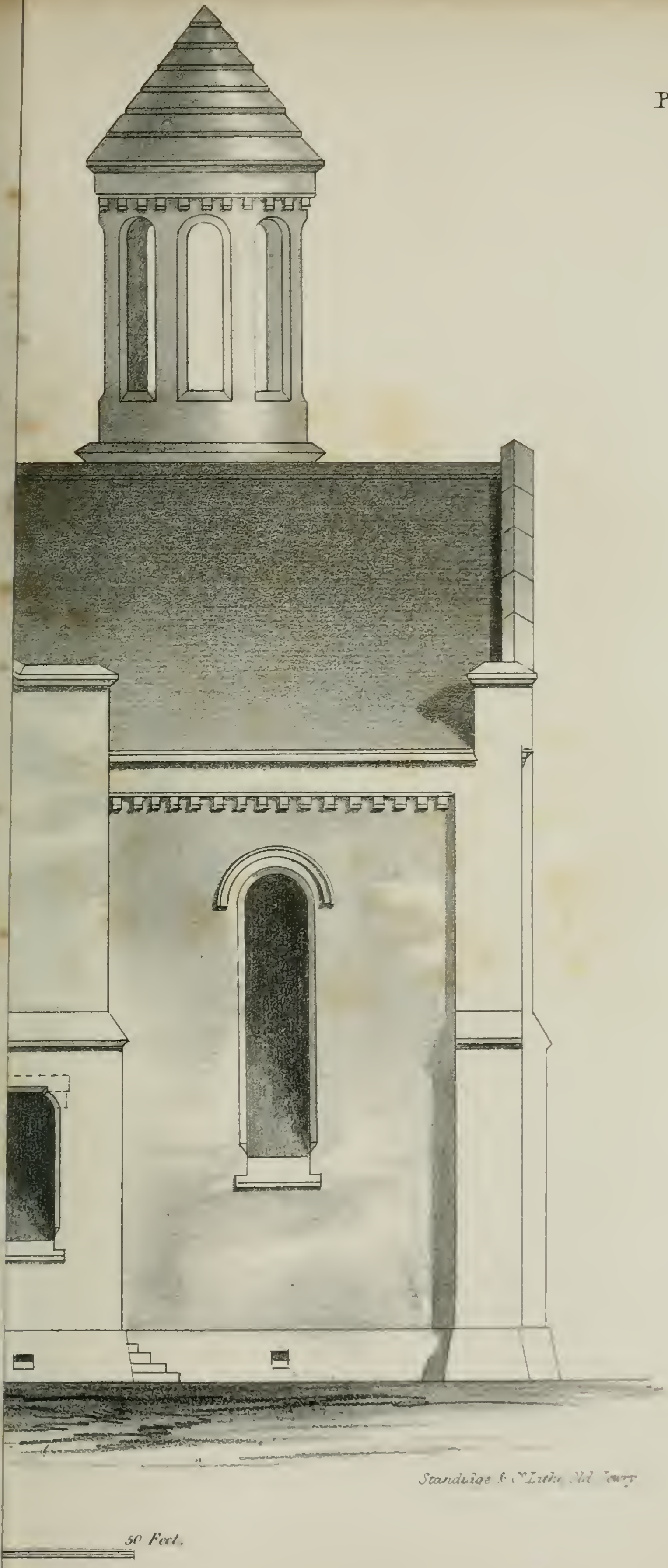
FRONT ELEVATION.

Scale 10 Feet to an Inch.



Standidge & Cº Litho Old Jewry

Pl. 8.



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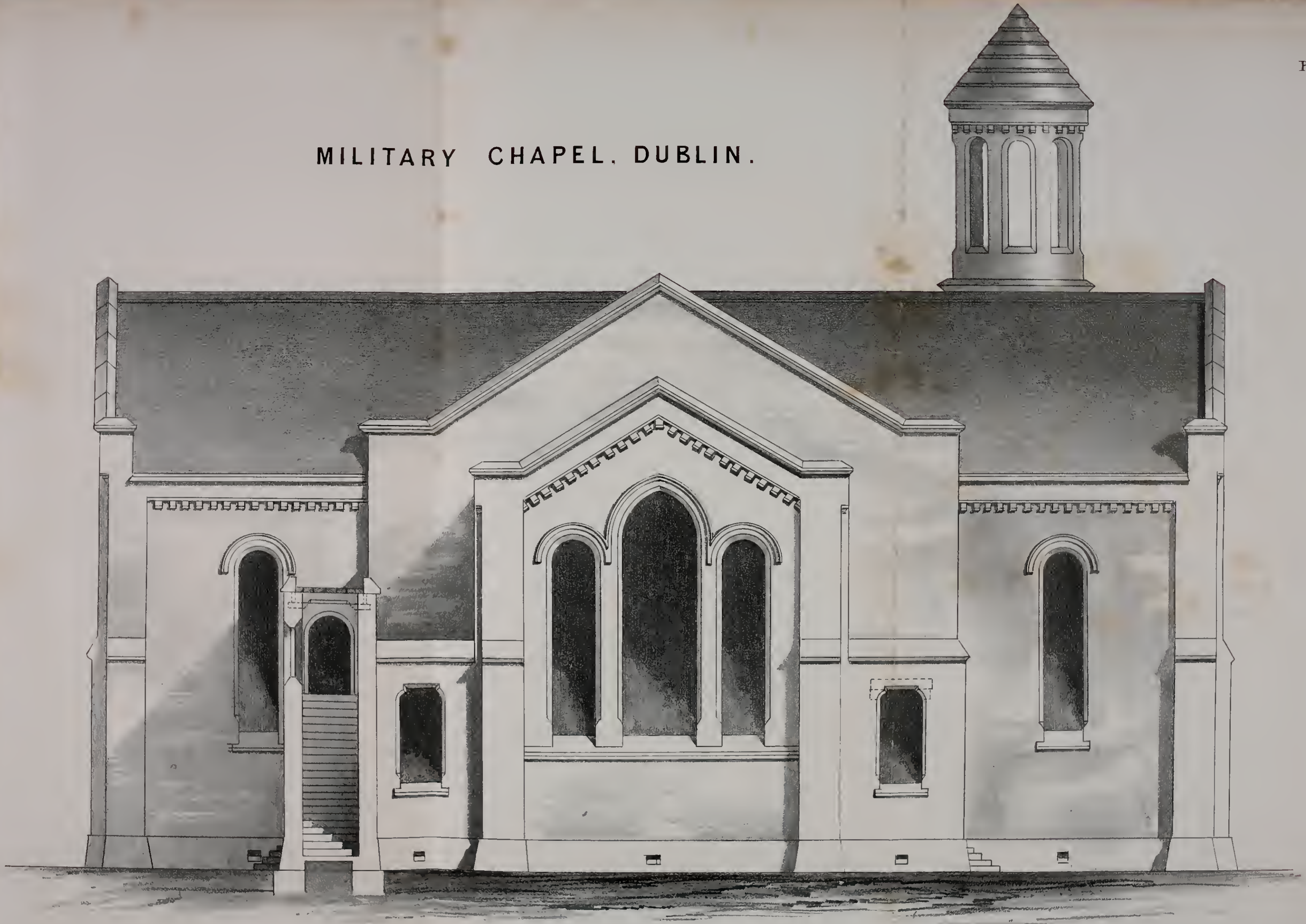
MILITARY CHAPEL, DUBLIN.



CHANCEL - END ELEVATION.

Scale 10 Feet to an Inch.

10 5 0 10 20 30 40 50 *Feet.*

Standidge & Co Litho, Old Jewry.

and finishing of the prison, chapel, governor's house, warder's lodges, and other out-offices, together with all the enclosure walls, entrances, gates, sewers, and every other appurtenance thereto belonging, notwithstanding any errors or omissions in the said terms of contract, general regulations, and specifications, without any extras or allowance for extra work which shall not have been executed by and with the consent, knowledge, and orders in writing, of the Commanding Royal Engineer of the Dublin District.

Commanding Royal Engineer's Office,
Dublin, 26*th April*, 1845.

Note to the Description of a Military Chapel.

(Copy.)

"18, Montpelier Hill, Jan. 29, 1849.

"My dear Sir,—In reply to your note of this day respecting the Garrison Church, I have very great pleasure in assuring you, that every day's experience confirms me in the opinion which I had long since formed, and have before expressed to Major Vicars—that, for its size, it is one of the easiest filled churches, by the voice, in this city. Since the pulpit and reading-desk have been removed to the centre, there has not been a single complaint in reference to hearing; and I feel confident that every word is distinctly heard, both from the desk and pulpit, in any part of the church, without any extraordinary effort on my part, and with less fatigue than I have suffered in churches less capacious. Several clergymen of this diocese, who have at times assisted me, concur in this opinion, and were distinctly heard in every quarter; they have assured me, that it is one of the most comfortable and best appointed churches that they have seen, and the pleasantest to speak in.

"GEORGE HARE,
"Chaplain to the Garrison.

"Major Lugard, Royal Engineers."

PAPER III.

THE QUEBEC and HALIFAX RAILWAY. By Major ROBINSON, R.E.

TOWARDS the close of the year 1838, Lord Durham, Governor-General of Canada, received a despatch from Her Majesty's Government, acquainting him with their determination to establish a steam communication between Great Britain and Halifax, and instructing him to direct his attention to the formation of a road between that port and Quebec.

In his Report on the Affairs of British North America, made in 1839, Lord Durham recommended that this road should be a railroad.

This, however, was not the first suggestion for a railway to connect Canada more closely with the mother country; for, in 1835, Captain, now Lieut.-Colonel, Yule, of the Royal Engineers, explored a line for a railroad from Quebec to St. Andrews, a port in the Bay of Fundy; but this line passing through the territory disputed between Great Britain and the United States, of which a great portion was finally ceded to the latter, it was never carried out.

The Cunard line of steamers between Liverpool and Halifax was established in 1840, and by them the communication between England and the continent of North America has been uninterruptedly kept up ever since, in the most efficient and admirable manner, under a contract with the British Government.

Instead of the railway to complete the communication onwards from Halifax to Quebec, it was at first proposed to construct a great military high road across the centre of New Brunswick, which was to branch off from the existing provincial roads near the bend of the Petitcodiac River, and join about the Rivière du Loup, the road leading from thence along the river St. Lawrence to Quebec.

In the year 1844 Captain Simmons, of the Royal Engineers, explored a line for this military high road.

But the rapid development of railroads in England and the United States of America, with the beneficial effects which everywhere attended their introduction, especially in the latter and neighbouring country, caused Lord Durham's suggestion of a railway to be revived.

Two or three private Companies, having this object in view, were projected in England during the general excitement which prevailed on the subject of railways in 1845 and 1846, but sank or expired during the collapse which followed soon after.

In the British Provinces, however, the intense interest which had been excited in its favour continued unabated, and resolutions were passed early in 1846, by each of the Houses of Legislature of the three provinces of Canada, New Brunswick, and Nova Scotia, in support of the project, and soliciting the aid of Her Majesty's Government towards it, undertaking, at the same time, to pay the expenses of the preliminary surveys and explorations.

These resolutions, with the previous correspondence and subsequent communications which passed between the Governors of the Provinces and the Secretary of State for the Colonies, had the effect of inducing Her Majesty's Government to send out an exploratory and surveying expedition from this country.

Captain Pipon, of the Royal Engineers, who had just returned to England from

America, where he had been engaged on the duties of the British Boundary Commission appointed under the Treaty of Washington, was selected by the Inspector-General of Fortifications to conduct it. Lieutenant, now Captain, Henderson was appointed to assist him, and thirteen non-commissioned officers and privates of the Royal Sappers and Miners, all belonging to the Survey Companies, were sent out with them.

The party left this country by one of the Cunard steamers in June, and arrived at Halifax on the 2nd July, 1846.

The instructions given to Captain Pipon for his guidance being too long to repeat here, it will be sufficient to give the following extracts from a letter addressed to him subsequently by the Under-Secretary of State for the Colonies, which contain essentially their spirit :—

" 1. Your instructions already authorize you to employ all the means of the country of which you can avail yourself, to enable you to perform the service with celerity and efficiency.

" 2. Although your instructions are very precise upon the point, Lord Grey thinks it right to remind you, that the first and principal object of the inquiry on which you are engaged, is that of furnishing Her Majesty's Government with such general knowledge as may enable them to decide which is the best line to be adopted for a trunk communication by railway through the British Provinces in North America, with reference to Imperial and Military, as well as to Provincial and Commercial Interests, and that no detailed survey of the country should be attempted, until the preliminary question as to the best line for a railroad through the country shall have been determined."

Captain Owen, of the Royal Navy, having suggested that the port of Whitehaven, near Canso, at the north-eastern extremity of Nova Scotia, should be the Atlantic terminus of the railway, in preference to Halifax, Captain Pipon was ordered to extend his explorations and inquiries to that harbour, and report upon the comparative advantages of that, or any other eastern port, for the terminus.

The operations being thus chiefly exploratory, a limited amount of instruments were purchased in England for the occasion ; viz. :—

8	Mountain Barometers, by Gay Lussac, or Simms. Syphon construction.
4	5-inch Theodolites, by Simms.
4	Measuring Chains.
20	Pocket Compasses.
1	Pedometer.
2	Rochon Telescopes; with some Thermometers.

Captain Pipon was, however, authorized to receive and make use of any of the instruments which were then in America belonging to the Foreign Office, and which were no longer required on the British Boundary Commission ; and according to his request, he received from Major Robinson, who was returning home from Washington *viâ* Halifax, in August :—

2	Mountain Barometers by Simms.
6	French Barometers. Syphon construction.
2	Box Chronometers.
4	Pocket Chronometers.
1	10-inch Sextant.
2	Prismatic Compasses (Schmalcalder's); with a few more Thermometers and Mahogany Pocket Compasses, for the use of the Sappers.

To these were added, early in the following year, also borrowed from the Foreign Office :—

1 6-inch Theodolite.
1 5-inch ,,
1 Schmalcalder's Compass.
1 3½-feet Pentograph.
1 3-feet Beam Compass.
2 4-feet Steel Straight-edges.
2 Cases of Drawing Instruments.
8 Books of Logarithms; with some minor articles for the use of the drawing room.

It may be mentioned here, that aneroids were not at that time known, or some would have been certainly recommended to be taken, and fewer barometers.

In the course of the expedition full half of these were broken, and to repair them it was necessary to send them to England, causing much inconvenience and delay.

The pedometer was useless in the woods.

The rochon telescopes were of the greatest service, in rivers or places where chains could not possibly be used.

Tents, blankets, and all other articles of camp equipage, felling axes, &c., were purchased in the country, as required.

Canoes were either purchased or hired, as was found necessary or convenient.

The whole country to be explored, through New Brunswick, and that part of Lower Canada north of the Restigouche River, and extending from it to the banks of the St. Lawrence, is covered with a dense primæval forest, consisting, for the most part, of pine trees, whose sharp-pointed branches, when they are prostrated by age or the violence of winds, form a regular abattis, and, with a thick undergrowth of shrubs and bushes, they render these woods almost impervious. Parties exploring, as soon as they leave the rivers or beaten tracks, have to cut their own way before them.

The difficulties of exploring, in such a country, are very great. The hills being as much covered with the forest as the lower portions, it is not easy to obtain views of the surrounding country, and generally it is only to be done by climbing.

Some of the Sappers became clever at this, and, assisted by creepers (a contrivance of iron spikes) buckled to the feet, could climb well.

In Nova Scotia the same difficulties were not experienced, there being many good country roads, of which advantage was taken whenever possible; and the woods are not so impenetrable as in New Brunswick.

In the latter province there are two good high roads, one on the east side, and another on the west, which lead to the banks of the St. Lawrence; but north of the one which connects Fredericton with Boistown and Chatham, on the Miramichi River, there are no cross roads by which the interior of the country can be reached.

The rivers and streams afford the only means of access, and when these are left, the exploring party must cut out its own path.

The plan of proceeding was generally as follows : –

From the best information that could be obtained, either from persons acquainted with the country or derived from former explorations, certain lines were selected for trial and examination.

Three or four parties were formed, each consisting of generally one civil surveyor (engaged in the country), two Sappers as assistant-surveyors, and a party of ten to twelve labourers, who were hired for the season. These were chosen from the lumber-men of the country—men accustomed to the woods,—and their duty was to carry the camp equipage and provisions, cut out and form carrying paths, &c. They were also generally found to be good canoemen.

Each party was given a particular line to explore. The Sappers carried either two or three barometers with them, as could be spared, the same number of detached thermometers, one 5-inch theodolite, and a measuring chain, pocket-compasses, &c. As the lines were cut out, they were measured, and the angles taken for direction, and also for elevation or depression. The barometers were registered at the summits of ridges and bottoms of valleys, the time of registry being carefully noted.

Somewhere, at the most convenient spot in the neighbourhood of the exploring parties, a Sapper was stationed with a standard barometer, who did not move from his post until ordered to do so, whose duty it was to register his barometer and thermometers every hour during the day.

By a comparison of his registry afterwards with that of the party in the woods, the means were obtained of making a barometrical section of the line, in addition to that given by the theodolite. Halifax, Truro, Whitehaven, Chatham, Campbelltown, points close to the sea, were thus selected for standard barometer stations. The Grand Falls, whose height above the sea was well known, was also one. The formula used for the reduction of the observations was Bailey's and the tables given in Simm's Treatise on Mathematical Instruments.

One great difficulty, and which formed a heavy item in the expenses, was to keep the parties supplied with provisions, for the quantity which could be carried on the backs of the labourers, in addition to their ordinary burdens of tents, blankets, axes, camp-kettles, &c., was not sufficient to last them many days. About 70 lbs. weight, including everything, was considered a fair load for a man to carry on his day's march.

It was therefore necessary to establish at different points depôts of provisions. Supplies were purchased at Fredericton, and sent up the river St. John to the Grand Falls and Madwaska, and then carried up in canoes to the head of Green River, where they were deposited in a log-hut built by the boatmen, and left in charge of a trustworthy labourer.

Much in the same way, a depôt was formed on the Tobique River, where the lines cross it; another up the Restigouche River.

Sometimes the provisions were sent up the rivers in canoes, or in large flat-bottomed boats, drawn by horses, and accompanied the parties, as up the Metapedia River, &c.

Biscuit, salt pork, and salt beef, with tea and brown sugar, formed the staple articles of diet.

No spirits or beer were permitted to be taken. Three meals per day, the fare at each being the same, and not restricted as to quantity. Tea was the great luxury at every meal, and it was surprising to witness the refreshing and strengthening effect it had upon the men after hard work.

To supply a party exploring south-east of Trois Pistoles, on the St. Lawrence, provisions had to be sent from Quebec to that place, and thence carried into the woods by labourers hired for the purpose.

As the distance increased from the river side, the carrying party increased also, for they themselves had to be fed on the journey out and back.

At the last portage, the number carrying amounted to twenty.

The exploring party then, however, acquired a surplus stock, with which to take a departure in search of the depôt at the head of Green River.

Some idea of the impracticable nature of the forest may be formed from the fact, that at this time the men cutting could not clear out, for the others to follow them, much more than three miles per day.

In these woods it is unsafe to wander in the least degree from the path cut or marked out. The danger of being lost is very great.

In the first season, Captain Henderson and three labourers, exploring in the difficult country about the Upsalquitch River, lost their bearings, and were out for three whole days and nights without a morsel to eat.

When they found themselves fairly lost, they adopted the best alternative left them, which was to follow a running stream.

By scrambling during the day along its banks, or wading in its bed, and at night sleeping under the shelter of the most favourable tree, they at the end of that time reached its confluence with a larger stream, where to their great relief they found a small quantity of provisions stored under a log-shed, to secure them from the bears. It was a deposit, or câche, made by some lumbermen to serve a future purpose. But for this providential circumstance they must have all perished from hunger and fatigue.

In the second season, one of the civil surveyors, Mr. Grant, of the Crown Land Office, New Brunswick, was lost for five days, being rescued in the last stage of starvation, his limbs paralyzed and extremities frost-bitten. An interesting account of this most providential escape was published in Chambers' Edinburgh Journal for June, 1848, No. 231. But the most unfortunate catastrophe which occurred early on this expedition, was the melancholy fate of Captain Pipon, who was accidentally drowned, on the 28th October, 1846, only a few months after his arrival in the country.

He was descending the Restigouche River, which falls into the Bay Chaleurs, in a canoe, with his boatman and a boy, whom he had engaged at a settler's house to act as a guide down the river.

On passing through a part called the Suction Rapids, the rickety canoe, owing to some inadvertent movement of the parties on board, upset.

Captain Pipon and the man reached the shore in safety, but the boy remained clinging to the bow of the canoe.

Moved by his cries for assistance, Captain Pipon plunged again into the stream, and endeavoured to reach him, but in vain. Encumbered with heavy boots and pea-coat, and probably numbed by the cold, he soon sank in the rapid current, and was carried down the stream. The body was found in about two hours after. The boy was, very soon after the accident occurred, drifted safely to shore on the canoe.

Captain Henderson, who was at the time some hundred miles higher up the river, upon hearing of it, hastened to Campbelltown, and from thence had the body immediately conveyed to Fredericton, where it was interred with military honours in the public cemetery.

His sad fate was universally regretted. The Legislature of New Brunswick voted a sum of money to defray the expense of a monument to be placed to his memory in the Cathedral at Fredericton.

A tablet to his memory was also placed, by the joint subscriptions of thirty of his personal friends in the Corps, and the members of the Boundary Commission, with whom he had so lately served, in the parish church of his family, at St. Breladcs, in the Island of Jersey.

At his death, Captain Henderson succeeded to the command of the expedition. The winter having set in, the parties were withdrawn from the woods, and returned, part to Fredericton, part to Halifax. The labourers were paid off, and the Sappers employed making plans and sections of the lines explored.

Early in 1847 Major Robinson was sent out to succeed Captain Pipon, and remained in charge of the expedition until the completion of its labours, and the return of the parties to England in October, 1848.

Reports of progress and proceedings were sent home from time to time.

The following papers comprise the final reports of the officers and civil surveyors* engaged.

The despatches, and documents* which follow them, are given to show the proceedings which took place thereon, by Her Majesty's Government and the Colonies, and the present prospects of the railway being carried out.

The unfavourable view which Her Majesty's Railway Commissioners took of the line soon or ever becoming a remunerative one, was fatal to its immediate adoption by the British Government.

A better opinion of its merits has since prevailed; but in the meanwhile a rival project—that of the European and North American Railway—has sprung up, and met with considerable favour in the provinces of New Brunswick and Nova Scotia.

The object of this railway is to facilitate the communication between England and the United States, by making a railway from Halifax, or some other port in Nova Scotia, to run to St. John's in New Brunswick, and thence on to meet a line from Bangor in Maine, to the boundary at Calais.

By the time it is constructed, or long before, it is expected that the lines from New York to Bangor, and from Portland to Montreal, will be completed.

The British Government, however, as will be seen by the despatch of the 10th March, 1851, have been induced to come forward and offer most valuable aid and assistance to enable the three provinces interested to make the Halifax and Quebec line, and to Montreal in addition.

The result of this offer remains to be seen.

The provinces are not now so unanimous in favour of the project as they were two or three years ago, the American line having many advocates who give it a preference.

WM. ROBINSON,
Captain Royal Engineers, Brevet-Major.

Exeter, July 4, 1851.

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* Too voluminous to be inserted in this work. It may be stated, however, that in 1849, the Legislatures of the three provinces passed Acts to the effect that, if Her Majesty's Government would undertake the construction of the line, either directly or indirectly, through the instrumentality of a private Company, they would *each* contribute 20,000*l*. per annum towards making good any deficiency in the income, give the ungranted lands for ten miles on each side of the line, and obtain, or pay for all the land required for the line of railway, for stations and termini. New Brunswick limited to twenty years her grant of 20,000*l*. per annum.

PAPERS relative to the QUEBEC and HALIFAX RAILWAY.

No. 1. (No. 299.*) No. 1.

COPY of a DESPATCH from Earl GREY to Governor-General the Earl of ELGIN and KINCARDINE.

MY LORD, Downing Street, November 17, 1848.

1. The Commissioners appointed by Her Majesty's Government to explore and survey the line of country offering the greatest advantages for the formation of a railway from Halifax, through New Brunswick to Quebec, having completed the duties with which they were charged, I have now the honour to transmit to your Lordship the final report of Major Robinson, addressed to the Inspector-General of Fortifications.

August 31, 1848. 2. I have perused this able document with the interest and attention it so well merits, and I have to convey to you the assurance of Her Majesty's Government that we fully appreciate the importance of the proposed undertaking, and entertain no doubt of the great advantages which would result, not only to the provinces interested in the work, but to the empire at large, from the construction of such a railway; but great as these advantages would be, it is impossible not to be sensible that the obstacles to be overcome, in providing for so large an expenditure as would be thus incurred, would be of a very formidable kind.

Before, therefore, Her Majesty's Government proceed to consider the question as to whether any steps should be taken to carry this plan into effect, it is necessary that we should be informed how the several provinces would be prepared to co-operate in its execution.

3. It is obvious that the cost of the work would be too great, as compared to the return, to be anticipated from the probable traffic, to give reasonable hope of its being undertaken by any Company as a private speculation. The question, therefore, arises, whether it would be expedient that in some form public assistance should be given towards the accomplishment of an object in which the public is so much interested.

4. The answer to this question must, in a great measure, depend upon the degree of importance which the provinces attach to the opening of this line of communication, and upon the amount of exertion they would be prepared to make for the purpose. I am, therefore, anxious that the subject should be brought under the early consideration of the respective Legislatures, and that I should be placed in possession of their views with respect to it as soon as may be practicable.

5. In forming a judgment, as to whether public assistance ought to be given towards the execution of the work, it will be necessary to take into consideration the different ways in which this might be done. Various modes of proceeding have been proposed: one is, that of endeavouring to form a Company, by guaranteeing to them a certain minimum interest on the capital, to be invested in the undertaking.

This plan would, no doubt, possess some advantages; but on the other hand it would be attended with the disadvantage of depriving the public of the proper control over a great national work, and also of having a tendency to encourage inattention to economy, both in the construction and subsequent working of the line. This last objection has been met, by proposing that any company formed to construct the line should receive assistance, not in the form of a guarantee of any given rate of interest, but of a fixed payment either of capital towards the execution of the work, or of an annual sum of money in addition to the receipts derived from traffic when the line is completed.

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* Similar Despatches addressed to the Lieut.-Governors of Nova Scotia (No. 131, Nov. 17) and New Brunswick (No. 78, Nov. 17).

6. Another plan which has been suggested is, that the required capital should be raised by loan by the Government, and contracts entered into for the formation of the line, which, when finished, could be worked either by the Government, or by any Company formed for that purpose, and to which Company the working of the line might be leased, under such conditions and for such a period as might be deemed advisable. The objections to this proposal are those usually raised against the undertaking of such a work by a Government, while on the other hand it would be attended with these advantages: first, that probably the capital required would then be raised on better terms than could otherwise be expected; and secondly, that the Government would have a more complete control over a great national line of communication.

7. I am not able at present to pronounce any opinion in favour of one or other of these plans, or even in favour of the measure being attempted at all; but I merely throw out these different suggestions for the consideration of your Lordship, and of the Executive Council and Legislature of Canada.

8. It will further be very material to consider what return is to be expected for the outlay, and from what source the means of affording any pecuniary assistance, to be given by the respective provinces, can best be provided. Upon this part of the subject I have to remark that, in estimating the probable return which the railway would yield, it appears to me highly necessary to advert, not only to the direct return from the traffic, but to the indirect return from the increased value given to the lands through which it will pass. That the opening of the line would, in the districts it traversed, greatly enhance the value of the lands which are still lying waste, and also, though in an inferior degree, the value of those already settled, there can be no reasonable doubt, though I do not possess the means of judging whether the amount of that increased value has been correctly estimated by Major Robinson in his report. Hence it seems to follow, that this increased value ought to be made available towards the execution of the work, and I would suggest, for the consideration of the Colonial Authorities, whether it might not be advisable that Acts should be passed, vesting in the hands of the Commissioners to be appointed for that purpose, all the hitherto ungranted lands lying within a certain distance of the line, in order that these lands might be sold or otherwise appropriated for the promotion of the undertaking.

9. It might also, I think, be very reasonably enacted, that lands lying within a given distance of the line should be subjected, on its being completed and opened, to some moderate charge, in the nature of a rate, in consideration of the benefit the proprietors receive from it. The practice is general both in this country and in America of rating for the highways the property which is benefited by them, and I can see no reason why this rule should not be extended to railways. Should this suggestion be adopted, it would, I think, be expedient to give the owners of lands subjected to this charge the option of redeeming it

upon easy terms, and of paying in land where they might have a difficulty in doing so in money.

I understand from Major Robinson, that the owners of land in one portion of Nova Scotia have already offered to contribute liberally to this object.

10. In addition to the value which the different Legislatures would be prepared to contribute in land, or by the imposition of a local charge upon lands benefited by the line, it would be necessary also for them to consider respectively what amount they would be willing to grant from the general revenue of the provinces towards the payment either of the interest of a loan to be raised for the execution of the work, or towards the sum which might be required to make good the engagements entered into with any Company that might undertake it.

11. The whole subject is one of the very highest importance, on which I shall be anxious to learn the conclusions to which the Colonial Authorities may come, after mature consideration, and after such communication with each other as may be necessary.

I have, &c.,
(Signed) GREY.

The Right Hon. Earl of Elgin and Kincardine,
&c., &c., &c.

Enclosure in No. 1.

Enclosure in No. 1.

REPORT on the PROPOSED TRUNK LINE of RAILWAY from an EASTERN PORT in NOVA SCOTIA, through NEW BRUNSWICK, to QUEBEC.

Halifax, Nova Scotia, August 31, 1848.

Three principal lines or routes for a trunk line of railway present themselves for consideration; and, by combining portions of two of these lines together, a fourth and fifth route may be formed.

1st. Commencing at Halifax and crossing the province of Nova Scotia to a port in the Bay of Fundy, from thence by a steamer to St. John, in New Brunswick, and then by Fredericton, along the St. John River to the Grand Falls.

From the Grand Falls, by the best practicable route across to the mouth of the Rivière du Loup, on the St. Lawrence, and by the right bank of the St. Lawrence to Quebec.

The distance by this route would be as follows:—

	Miles.
Halifax to Windsor	45
Windsor to Annapolis	85
Annapolis to entrance Bay of Fundy	11
Across Bay of Fundy to St. John (by sea)	45
St. John to Fredericton	65
Fredericton to Woodstock	62
Woodstock to the Grand Falls	71
The Grand Falls to the mouth of the Rivière du Loup	106
Rivière du Loup to Quebec	110
Total distance, Halifax by the St. John River to Quebec	600

This line may be termed a mixed route, by railway and steam-boat.

2nd. Commencing at Halifax and running to Truro, at the head of the Bay of Fundy, thence over the Cumberland Mountains to Amherst, then along the coast from Bay Verte to Shediac, thence by a north-westerly course, crossing the rivers Richibucto and Miramichi above the flow of the tide, so as not to interfere with the navigation.

Then by the valley of the north-western Miramichi to Bathurst, on the Bay Chaleurs, along the coast of this bay to the Restigouche River, and by it, and the valley of the river Metapedia, to the St. Lawrence, and by the right bank of the St. Lawrence to Quebec.

The distance by this route would be as follows:—

	Miles.
Halifax to Truro	55
Truro to Amherst and Bay Verte	69
Bay Verte to Shediac	26
Shediac to Miramichi River	74
Miramichi River to Bathurst	56
Bathurst to the Eel River, near Dalhousie	48
Dalhousie to the mouth of the Metapedia River	30
Metapedia River to the mouth of the Naget River, near the St. Lawrence	86
Along the St. Lawrence from this point to Quebec	191
Total distance by this route	635

This, for the sake of reference, may be called the Halifax and Eastern or Bay Chaleurs route through New Brunswick to Quebec.

3rd. Commencing at the harbour of Whitehaven, near Canso, at the north-eastern extremity of Nova Scotia, thence along the Atlantic coast to Country Harbour and valley of the river St. Mary, thence by or near to Pictou, and along the northern shore to Bay Verte.

From Bay Verte to or near to the bend of Petitcodiac, thence across to Boistown, and northerly to the Restigouche River, crossing it several miles to the east of the Grand Falls.

From thence by the most direct and practical course to the Trois Pistoles River, and along the right bank of the St. Lawrence to Quebec.

The distance by this route would be nearly as follows:—

	Miles
Whitehaven to Country Harbour	40
Country Harbour to St. Mary's Valley and Pictou	64
Pictou and along the coast to Bay Verte	77
Bay Verte to bend of Petitcodiac	40
Petitcodiac to Boistown	80
Boistown to the crossing of the Restigouche River	115
Restigouche River to Trois Pistoles, by the Kedgwick and Rimouski Valleys	105
Along the St. Lawrence to Quebec	131
Total distance from Whitehaven, by Boistown, to Quebec	652

This may be termed the direct route.

4th. Combining the Halifax route through Nova Scotia, and the direct route through the centre of New Brunswick.

The distances will be probably as under .—

	Miles.	
From Halifax by Truro and Amherst to Bay Verte, as per route No. 2	124	In Nova Scotia.
Bay Verte to the bend of Petitcodiac, Boistown, Restigouche River, as per route No. 3 . .	235	In New Brunswick.
By the Kedgwick and Rimouski, to the mouth of the Torcadi	75	In Canada.
Mouth of the Torcadi to the crossing of the Trois Pistoles River	30	
Along the St. Lawrence River to Quebec . .	131	
Total distance from Halifax to Quebec by this route	595	

5th. Combining the Whitehaven route through Nova Scotia with the Eastern or Bay Chaleurs route through New Brunswick to Quebec, the distances will be as under :—

	Miles.	
From Whitehaven, by Pictou and the North Coast, to Bay Verte, as in route No. 3 . .	181	In Nova Scotia.
From Bay Verte to the Bay Chaleurs, and mouth of the Metapedia, as in route No. 2 . .	234	In New Brunswick.
Mouth of the Metapedia River to the mouth of the Naget	86	In Canada.
Along the St. Lawrence to Quebec . . .	191	
Total distance from Whitehaven to Quebec by this route	692	

Thus the distances will be as under :—

	Miles.
1st. By the mixed route, Halifax to Annapolis, by the St. John to Quebec, the distance will be	600
2nd. By the Halifax and Eastern or Bay Chaleurs route to Quebec	635
3rd. By the direct route, Whitehaven, Boistown, and Quebec .	652
4th. By the Halifax, Truro, Amherst, and Boistown, to Quebec .	595
5th. By the Whitehaven, Bay Verte, and Bay Chaleurs, to Quebec	692

The first line fails in the most essential object contemplated by the proposed railway, viz., a free and uninterrupted communication at all times and seasons of the year from the port of arrival on the Atlantic terminus in Nova Scotia to Quebec.

The intervention of the Bay of Fundy is fatal to this route.

In summer the transshipment of passengers and goods to and fro would be attended with the greatest inconvenience, loss of time, and additional expense; whilst in winter it would be even still more inconvenient, and liable to be interrupted by storms and the floating masses of ice which then occur in the bay.

In the case of the conveyance of troops, transport of artillery and munitions of war, the crossing the bay would at any time be most objectionable; and if suddenly required in critical times, might be attended with the worst consequences.

Commercially, too, it would destroy the fair prospect of the proposed line from Quebec to Halifax competing successfully with the route by the Gulf of the St. Lawrence, and with rival lines in the neighbouring States.

But there are also other serious objections to be offered against it.

Passing through New Brunswick, and on the right bank of the St. John River, as it must necessarily do, to the Grand Falls, it would for a considerable distance, both before and after the reaching that point, run along and close to the frontier of the United States.

In case of war, therefore, or in times of internal commotion, when border quarrels or border sympathies are excited, this line, when most needed, would be the most sure to fail, for no measures could be taken which would at all times effectually guard it from an open enemy, and from treacherous attacks.

The passage across the Bay of Fundy, so close to the shores of Maine, would invite aggression, and require a large naval force for its protection.

The engineering difficulties, as the line approaches the Grand Falls from Wood. stock would not be easily overcome.

The space between the St. John River and the boundary line becomes gradually contracted to a width of not more than two to three miles, and the country is broken and rough, whilst the banks of the St. John are rocky and precipitous for many miles below the Falls.

From the Grand Falls to the St. Lawrence, a distance of more than a hundred miles, the country is so far known as to make it certain that there is very difficult and unfavourable ground to be encountered, which would require careful explorations and extensive surveying.

This intervention of the Bay of Fundy, therefore, and the proximity of this line, for a considerable distance, to the frontier of the United States, was so objectionable and fatal to this route, that the attention of the officers and the exploring parties was, after a slight examination of the country between Halifax and Annapolis, directed in search of other and more favourable lines.

To understand the comparative advantages possessed by the other routes, as well as to be able to weigh the objections which may be raised against each, and afterwards determine from their relative merits which is the best direction for the proposed line to take, it will be necessary, previously, to give some description of the country through which the lines pass, the present amount and distribution of the population, and the engineering difficulties which were met with along the lines examined.

As it will be seen in the end, that only one of the lines, viz., the second, has been explored and carried out successfully from its terminus on the Atlantic quite through to Quebec, it may be perhaps considered superfluous to enter upon the discussion of rival lines, but the object to be gained by so doing is to show that so much has been done and is known of the country as to render further explorations for new lines unnecessary, because, if completed, they would not be likely to be recommended in preference to the one which will be proposed for adoption.

The distance from the Atlantic coast of Nova Scotia to the bank of the St. Lawrence is about 360 miles in a straight line. Intersecting the country which must be traversed by any line of railway, and crossing its course at right angles, are five great obstacles which have to be either surmounted or avoided.

1. The first is a broad range or belt of high and broken land which runs along the Atlantic shores of Nova Scotia, from Cape Canso to Cape Sable. The breadth

varies from about 20 miles in its narrowest part, up to 50 or 60 miles in other places. Its average height may be about 500 feet. The strata of which it is composed consist of granite, slate, and a variety of rocks, hard and difficult to cut through. The characteristic features of the surface are rugged and uneven, and therefore very unfavourable for railway operations. No useful minerals of the metallic kind have been found in it, in quantities sufficient to work to advantage.

Valuable quarries of stone for building purposes are abundant, but these will be found everywhere nearly along the proposed line.

This formation is estimated to cover nearly two-thirds of the surface of Nova Scotia. It is, generally speaking, unfavourable for agriculture; the timber on it is stinted in growth, and it is an object of some importance to pass through it, and leave it behind as soon as possible.

If a line be drawn from the head of the estuary of the Avon, near Windsor, to the Great Shubenacadie Lake, and then across the Stewiacke River, along the upper parts of the streams in the county of Pictou, to the Gut of Canso, all the portion lying to the south of this line belongs to this formation, and all to the north of it to the more favourable and highly valuable formation of the carboniferous system.

The narrowest and shortest line by which this range or belt can be crossed occurs at Halifax, and at the same time, owing to a favourable break in the chain, at the lowest point in altitude; the summit level through it not exceeding 90 feet.

The Halifax line (route No. 2) is clear of it in 20 miles. Before the same can be done by the Whitehaven and direct line (route No. 3), it must follow the coast for upwards of 30 miles, as far as Country Harbour, and then a further course across it of another 30 miles; involving in this distance two, if not three tunnels, and must surmount a summit level of 400 feet.

2. The second great obstacle is the Bay of Fundy. This, as stated, is fatal to the first route. By the other routes it can be turned and avoided.

3. The third obstacle is the range of Cobequid Hills. These extend all along the north shore of the Bay of Minas, and very nearly across but not quite to the shore at the Straits of Northumberland. In breadth, the range preserves nearly an uniform width of about 10 miles. In altitude, the hills average from 800 to 1000 feet. The lowest point, after a careful survey, was found to be, at the Folly Lake, 600 feet above the sea. This range can be avoided and passed by the Whitehaven and direct route, but must be surmounted and crossed over by the Halifax and Eastern line (route No. 2).

The prevailing rocks are granite, porphyry, and clay slate, in the upper portions; along the shore of the Bay of Minas and on the northern side, the formation is of the red sandstone and the coal measures.

This range abounds with the most valuable minerals, of which a large mass of specular iron ore, of unequalled richness, occurs close to the line, and only requires facility of carriage for bringing coals to the spot, to be worked with profit.

A large portion of this tract still remains ungranted, and timber of excellent growth, with abundance of the finest stone for building purposes, are to be met with, and, still belonging to the Crown, can be had for the expense of labour only.

4. The fourth obstacle is the broad and extensive range of the highlands which occupies nearly the whole space in the centre of New Brunswick from the Mira-

michi River north to the Restigouche. Some of these mountains rise to an altitude exceeding 2000 feet.

The Tobique River runs through them, forming a deep valley or trough, which must be crossed by the direct line, and increases greatly the difficulty of passing by them.

The lowest point of the ridge, overlooking the Tobique River, at which any line of railway must pass, is 1216 feet above the sea. Then follows a descent to the river of 796 feet in 18 miles, and the summit level on the opposite ridge or crest between the Tobique and Restigouche waters is 920 feet above the sea, or a rise of 500 feet above the point of crossing at the Tobique water. These great summit levels, which must be surmounted, form a serious objection to this route.

The Eastern line, by the coast, avoids this chain altogether. The greatest summit level along it will not be above 368 feet, while the distance by each from the province line at Bay Verte, to the Restigouche River (the northern limit of New Brunswick), will be as nearly as possible the same, there being only a difference of one mile in these two routes through this province.

The rocks composing this chain of mountains are granite, various kinds of slates, grauwacke, limestone, sandstone, &c.

5. The fifth and last obstacle to be overcome, and which cannot be avoided by any of the routes, is the mountain range running along the whole course of the river St. Lawrence, in a very irregular line, but at an average distance from it of about 20 miles. It occupies, with its spurs and branches, a large portion of the space between the St. Lawrence and the Restigouche River. The rocks and strata composing the range are of the same character and kind as the Tobique range. The tops of the mountains are as elevated in the one range as in the other.

The exploring parties failed in finding a line through this range to join on to the direct line through New Brunswick, but succeeded in carrying on the Eastern or Bay Chaleurs route, owing to the fortunate intervention of the valley of the Metapedia River.

The line which was tried and failed was across from the Trois Pistoles River, by the heads of Green River, and down the Pseudy, or some of the streams in that part, running into the Restigouche River.

A favourable line from the Trois Pistoles was ascertained along the Eagle Lakes and Torcadi River, as far as the Rimouski; and it is probable that by ascending this river, and descending the Kedgwick River, this line (route No. 4) could be completed.

But it is most improbable that it could compete in favourable grades with the Metapedia.

It will be allowing it sufficient latitude to suppose it will be equal in engineering merits, and that, if accomplished, it will give the route No. 4 an apparent advantage of 40 miles in distance.

A very striking characteristic in the geological formation of North America, and which has been noticed in the writings of persons who have described the country, is the tendency of the rock strata to run in parallel ridges in courses north-easterly and south-westerly.

On referring to the General Map, No. 1, and confining the attention more particularly to that portion of country east and north of the St. John River, through which any line must pass, this general tendency cannot fail to be remarked.

The river St. Lawrence, the main Restigouche River and intermediate chain of mountains, the Tobique River and mountains, and all the streams in New Brunswick (the main trunk of St. John, and a branch of the Miramichi excepted).

The Cobequid Range, the Bay of Fundy, and the high and rocky range along the Atlantic shore, have all this north-east and south-western tendency.

It will be evident, therefore, that any line from the coast of Nova Scotia to the St. Lawrence has a general direction to follow, which is the most unfavourable that could have occurred for it, having to cross all these mountain ranges, streams, and valleys at right angles nearly to their courses.

The lines explored for the direct route through New Brunswick were obliged, on this account, to keep the elevated ground crossing the upper parts of the streams.

By so doing a line was found to the Restigouche, which may be considered just within the limits of practicability, but having very unfavourable summit levels to surmount.

And the peculiar formation of the strata and general course of the valleys and streams, renders it most improbable that any further explorations to improve this direct line through New Brunswick would be attended with much success.

Very fortunately for the Eastern line, one of the branches of the north-western Miramichi presented itself as an exception to the general tendency, and enabled that line to reach the coast of the Bay Chaleurs.

The distance across in a direct line from the coast of Nova Scotia to the St. Lawrence has been stated at about 360 miles, forming the difficult and unfavourable portion of the line. When the St. Lawrence mountains are passed, then the tendency of the strata and courses north-easterly and south-westerly becomes as favourable for the remaining 200 miles along that river as it was before adverse.

The general character of the ground between the St. Lawrence River and the mountains, is that of irregular terraces or broad valleys rising one above another by steep short banks, having the appearance as if the river had at some former periods higher levels for its waters.

The streams run along these valleys parallel with the course of the St. Lawrence until, meeting some obstruction, they turn suddenly off and find their way over precipices and falls to the main river.

Having described such of the physical features of the country which form obstacles in the way of the lines under consideration, it is proper next to describe those features and other resources which are advantages, and should be sought for by competing lines.

The geological systems which prevail through the intermediate country to the mountain ranges, are the carboniferous and new red sandstone.

They include large deposits of red marl, limestone, gypsum, freestone of excellent quality for building purposes, and extensive beds of coal. Indications of the latter are met with in abundance from the banks of Gay's River (20 miles from Halifax) up to the Restigouche River, and along the shores of the Bay Chaleurs.

Wherever these systems and minerals are found, a strong and productive soil, favourable for agricultural pursuits and settlement, is sure to accompany them.

The surface of such a country, too, is generally low, or moderately undulating, and therefore the more of such a district that a line can be led through the better for it.

In Nova Scotia, this formation occupies its northern section, and amounts to nearly one-third of its whole area. It then extends all over the southern and eastern parts of New Brunswick.

In this respect, therefore, the route No. 2 has a decided advantage.

The greatest and most valuable coal-field is that of Pictou.

It is situated on the south side of that harbour. The exact extent of the bed is not known, as it is broken by a great (geological) fault. It occupies, however, an area of many square miles.

The coal is bituminous, of good quality, and the veins of most unusual thickness.

Mines in it are extensively worked, and large exports from them are made to the United States. Iron ore is abundant.

This is an advantage in favour of the Whitehaven and direct route.

The next great coal district is the Cumberland field, and it is second only in importance to that of Pictou.

It is supposed to extend from the Macon River, west of Amherst, over to Tatmagouche, in the Straits of Northumberland.

Some mines in it have been recently opened, and promise to be very productive.

The line No. 2 passes over this field for miles, and may be considered, from that circumstance, as not being deprived altogether of an advantage possessed by the other route.

The great agricultural capabilities of the eastern counties of New Brunswick have been described in the reports of Mr. Perley, the Government Emigration Agent, which were presented to the New Brunswick Legislature in February, 1847, and ordered to be printed.

One most important object to be attained by the construction of the railroad is the settlement of the public lands, and the encouragement of emigration from the mother-country.

As bearing very strongly upon this point, in the choice of the best direction for the line, I subjoin the following extract taken from Bouchette's Work on Canada, vol. i., page 331. It is a quotation made by him from "The Commissioners' Report of 1821."

"The Bay of Gaspé, and particularly the *Bay des Chaleurs*, are susceptible of the most improved agriculture. For the establishment of emigrants, no part in Canada offers such immediate resources of livelihood as may be derived from the fisheries. It is a fact worthy of notice, that in the year 1816, when the lower parts of the province were afflicted with a famine from the destruction of the harvest by frost, no such inconvenience was experienced at Paspébiac, nor at any other place within the level tract above mentioned."

The tract alluded to here is not clearly defined by the quotation, but it is supposed to mean the whole district along the south shore of the Bay Chaleurs.

This tends to show the effect produced by the vicinity of the sea, in moderating the temperature and saving the crops from untimely frosts. In this respect, therefore, the line No. 2 has an important advantage over the one through the central and more elevated land of New Brunswick.

As the interior is approached, and the distance from, as well as the elevation above, the sea increases, the danger to crops from cold nights and early frosts also increases.

In the Madawaska Settlement, and on the Upper St. John River, great failures of crops have occurred from this cause, and wheat and potatoes are very liable to be destroyed.

From the Bend of Petitcodiac to the St. Lawrence, a distance of upwards of 300 miles, the direct line would pass through a perfect wilderness, with not a single settler on the whole line, except a few at or near to Boistown.

Leaving engineering difficulties for the moment out of the question, the cost of construction would be materially increased by the extra difficulties attendant on the transport of necessary materials, and in supplying with food the labourers and others engaged on the line.

This disadvantage is not shared by the second route, which can be approached in numerous places along the Gulf shore by means of bays and navigable rivers.

The direct line No. 4 will not have such advantages to present to settlers as the second. On the contrary, if adopted, it might be found necessary to incur expenses for the establishment of small communities along the line, to repair and keep it open.

The facilities for external as well as internal communication, and other advantages arising from commerce and the fisheries, which will be developed by the Eastern line (and entirely wanting along the direct route), will, it is fully expected, make its vicinity eagerly sought for by settlers, and that it will, in the course of no very great length of time, lead to the extension of that long-continued village which now exists with but little exception from Quebec to Metis (200 miles), from the shores of the St. Lawrence to the Atlantic Ocean.

It must be premised that a branch railway from the city of St. John is contemplated to pass up the Valley of the Kennebecasis, and connect with the main trunk at the Bay of Shediac.

The survey of this line, ordered by the Provincial Government, is in progress; and from the latest information received, the line promises most favourably.

The total population of New Brunswick has been estimated to amount, at the beginning of 1848, to 208,012, distributed in the proportions as under:—

County of Restigouche	4,214	
" Gloucester	10,334	
" Northumberland	19,493	
" Kent	9,769	43,810
" Westmoreland and Albert	23,581	
" King's	19,285	
" St. John	43,942	86,808
" Queen's	10,976	
" Sunbury	5,680	16,656
" York	18,660	
" Carleton	17,841	36,501
" Charlotte		24,237
Total		208,012

Of these, the first four, amounting to 43,810, are on the line of the proposed route No. 2, and will be entirely thrown out by the adoption of the other.

Campbellton, Dalhousie, Bathurst, Chatham on the Miramichi, and Richibucto, seaports and shipping places of consequence on the Gulf shore, all of them susceptible of the greatest development, will be left isolated and cut off.

These ports are ice-bound during the winter months; and railway communication will be to them of the greatest importance.

It will affect most materially the interests of the city of St. John, and the receipts upon their branch railway.

It will affect also most sensibly the receipts of the main trunk line.

Along the south bank of the St. Lawrence, from Quebec to Metis, there are settled along it, in what can be only compared to one continued village for 200 miles, 75,000 inhabitants.

Of these also a large population, probably 12,000 in number, residing between the Rimouski and Metis River, will be deprived of the benefit of the railway if the direct line be adopted.

To counterbalance the serious detriment which would thus be caused, this line would diminish the length of the branch line likely to be made to connect it with Fredericton, which is the seat of Government, and contains about 6000 inhabitants.

The population of Nova Scotia may be estimated to be about, viz. :—

City of Halifax and County	40,000
County of Cumberland	10,600
„ Colchester	14,900
„ Pictou	30,300
„ Sydney and Guysborough	23,200
Remaining Counties	111,200
Total	230,200

The population of Cape Breton is estimated at 49,600.

Of the above, if the Whitehaven and direct route be adopted, the city of Halifax and county, amounting to 40,000, will be excluded from the benefit of the line.

If the Halifax and Eastern line (route No. 2) be adopted, then the population of Sydney and Pictou, amounting to 53,500, will be excluded.

To the population in the southern or remaining counties (111,200), the Halifax route will be of essential benefit.

From the other route they would derive no advantage whatever.

It is now proposed to give an account of the explorations and their results.

The dotted lines on the General Plan show where these were made, and the courses taken.

In the season of 1846, the Cumberland Hills were very carefully examined; sections with the theodolite were made, and barometrical observations taken, to ascertain the lowest and most favourable point for crossing them.

The line which had been cut out and explored for the military road was followed from the Bend of Petitcodiac to Boistown.

From Boistown the general course was followed, and levelled as far as the Tobique River; but the country was so unfavourable that new courses had to be constantly sought out.

A new line altogether was tried from the Tobique, as far as the Wagan Portage.

The results deduced from the observations and sections proved this line to be quite impracticable for a railway.

Whilst this line was being tried, other parties explored from Newcastle on the Miramichi River over to Crystal Brook on the Nipisiguit, the valleys of the Upsalquitch and its tributaries, and as far as the Restigouche River.

The country at the upper waters of the Nipisiguit, and the whole of the Upsalquitch valleys, were found to be rough, broken, and totally impracticable.

The result of this season's labour went to show, that the best, if not the only, route that would be likely to be practicable, would be by the north-west Miramichi to Bathurst, and then along the Bay Chaleurs.

During the winter a small reconnoitring party (on snow shoes) was sent up the Metapediac Valley, as far as Metallis Brook, and they made their way across the country, from thence to the mouth of the Torcadi River on the Rimouski.

Their report on this line was rather favourable, and had there been any necessity for it, it would have been more fully explored the next season (1847).

As soon as this was sufficiently advanced to admit of the parties entering the woods, the explorations were resumed.

A grade line was carried over the Cumberland Hills. It was cut through the woods, from the foot on one side to the foot of the slope on the other, a distance of 10 miles, and carefully levelled with a theodolite. This proved it to be quite practicable.

The exploration of the Eastern line was again taken up.

It was commenced at the head of the tide, on the south-west of Miramichi, and was carried up the valley of the north-west Miramichi, over to, and down the Upsalquitch River to Bathurst, and along the shores of the Bay Chaleurs to the Restigouche, up the Metapediac to the Metis, and along the bank of the St. Lawrence to the Rimouski and Trois Pistoles River.

The result of this exploration was so satisfactory that the party engaged upon it returned by the same route, surveyed it, and took the levels along it back to the Miramichi River.

An exploratory line was then cut through the greater portion of the flat and generally level country between this river and the province line at Bay Verte.

An examination of the country was made from the Trois Pistoles River along the St. Lawrence to Quebec, which, with what had been done in Nova Scotia, during this and the former season, completed the whole of one good and favourable line from Halifax to Quebec.

The details are given in the accompanying Report, Appendix, No. 1; General Plan, No. 1; Model Map, No. 2; and Book, containing exploratory sheets, No. 16, containing plans and sections of the whole route, and comprises the line recommended to be adopted.

Unwilling to abandon the direct route through the centre of New Brunswick, by which, if a line could be successfully carried out, the distance would be so materially shortened, as is apparent by the mileage given in route No. 4, it was determined to use every effort to decide either the practicability or impracticability of such a line. To this end large parties were employed the whole season.

One party explored, cut, and levelled a line the whole way between the Napadagan Lake and the Restigouche River, a distance of 96 miles.

The line explored was a very great improvement upon the one of 1846.

It is considered to be so far satisfactory as to prove that a line for that distance can be found which would be within the limits of railway gradients.

The details are given in the Assistant-Surveyor's Report, Appendix No. 2, with three exploratory sheets, Nos. 17, 18, 19, containing plans and sections of the ground passed over.

A large party was engaged in trying to find a line from Trois Pistoles River on the St. Lawrence, through the Highlands to the Restigouche River, for the purpose of connecting on to the New Brunswick party. The winter overtook them whilst still embarrassed in the Highlands at the head waters of the Green River.

The dotted lines on the General Plan will show their attempts.

A line was tried up the valley of the Abersquash, but it ended in a *cul-de-sac.* There was no way out of it.

A second line was carried from Trois Pistoles over to Lac-des-Isles, Eagle Lake; and by the middle branch of the Tuladi River, the north-west branch and head waters of the Green River were gained.

But this point was not reached, except by a narrow valley or ravine of four miles in length.

A theodolite section was made of it, and it was found to involve a grade of at least one in forty-nine, and to attain that, heavy cuttings at one part, and embankments at another, would be necessary.

There is no occasion at present to enter upon the discussion of whether this should condemn a whole line; for having attained the Forks, at the head of the main Green River, no way was found out of it; and this explored line, like the first-mentioned, must be considered to have ended in a *cul-de-sac* also.

Further details are given in the report of Mr. Wilkinson, the surveyor entrusted with the more immediate charge of this part of the line, in Appendix No. 3, with sketches attached to it.

It is just probable that a line might be found by way of the Kedgwick River and the Rimouski, as far as the mouth of the Torcadi River. From which, to the Trois Pistoles, there was ascertained to be no difficulty.

But as the advantages in every way, except distance, are so much in favour of the Eastern line, it would only be incurring delay, and perhaps useless expense, in further explorations of this part of the country.

In the Report (Appendix, No. 3) there is a third route suggested for examination and trial, viz., by one of the lower branches of the Green River and the Squattock Lakes.

Whether successful or not, it is liable to the objection of approaching the frontier of the United States.

There remains to be noticed the exploration for a line of railway from Whitehaven, on the eastern coast of Nova Scotia, towards Pictou and Bay Verte.

This was rendered necessary in consequence of the suggestion made by Captain Owen, R.N., to make Whitehaven the Atlantic terminus of the railway.

The details of this exploration are given in the accompanying Report, Appendix No. 4, and exploratory sheets, Nos. 20, 21, 22, and 24.

Engineering difficulties and expensive cuttings occur on this route.

From the commencement in the harbour of Whitehaven, the line must pass along a barren and rocky coast for upwards of 30 miles to Country Harbour, before it can turn off towards the interior. And it cannot do this and get clear of the sea-shore without the necessity of making a tunnel of about a mile in length through a ridge of whinstone.

Again, at the falls of the St. Mary River there will be required a tunnel of a quarter of a mile, and a viaduct across a valley of about 500 feet in length.

The summit level occurs between Lake Eden and Beaver Lake, and is 400 feet above the sea.

At Grant's Bridge, on the East River, for nearly three miles in length, there would necessarily be several expensive cuttings through rocks of sandstone and limestone.

The length of this line from Whitehaven to Bay Verte is estimated at 181 miles. From Halifax to the same point is 124; leaving a difference of 57 miles.

If the direct route No. 3 could be established, it would add 17 miles to the trunk line.

But as it is not to be supposed that Halifax, the capital and great commercial city of the province, would in such a case allow itself to be excluded from the benefits of the proposed railway, then it would involve, in addition to this 17 miles of trunk railway, a branch line of probably 90 miles.

Or if the Eastern Bay Chaleurs line through New Brunswick be added on to it, as in route No. 5, then it will involve no less than 57 miles extra of trunk line, and the same necessity for the branch line of 90 miles mentioned.

To compensate for such disadvantages, it must be shown that Whitehaven has the most paramount claims to be selected as the Atlantic terminus, in preference to Halifax.

The harbour of Whitehaven is 120 miles nearer to England, by sea, than Halifax; equivalent to, in ocean navigation by the steamers, to 10 hours.

This, it is readily conceded, is a very great advantage; and were there no drawbacks or other considerations in the way, it would be quite sufficient to give that port the preference.

It is a well-known fact, however, that there is a time and season in the year when the Cunard steamers cannot keep their direct course to Halifax even, but are compelled by fields of ice to keep to the southward, and sometimes pass to the south of Sable Island.

During this time, which occurs in the spring of the year, and may last for two or three months, there would be some risk in their making direct for the more northern port of Whitehaven. And if for these three months the steamers were obliged to make Halifax their port, then for that time the Whitehaven line would be useless.

In respect to the advantages which it is said to possess, of remaining open all the year round, it is not quite clear that it does so.

From inquiries made on the spot in the summer of 1847, Captain Henderson learned that the preceding winter the harbour had been frozen over entirely, five to six inches thick, and that it was sometimes blockaded up and much incommoded by ice.

Subsequently, however, and during this winter, when the objects of the inquiries made there in the summer became known, and the advantage of the railway spoken of, a statement, accompanied with affidavits, was forwarded, with a view to counteract the effect of the information given to Captain Henderson and the parties exploring there.

They are given in the Appendix, No. 5, to this Report.

They tend to show that though the immediate entrance to the harbour may be, and generally is, clear, yet that large quantities of floating ice find their way through the Gut of Canso, and by Cape Breton, which pass off in a southerly direction, crossing the direct path of steamers and vessels from Europe.

The coasting vessels keeping in shore are not so liable to be molested by it.

The harbour is admitted to be a fine sheet of water, but it does not, and cannot, vie with Halifax, either in appearance or capacity.

Referring to Lieutenant Shortland's Report, Appendix No. 5, who made a survey of it in obedience to the directions of Captain Owen, R.N., it appears that it is not free from the objection which is made against the port of Halifax, and is its only drawback, viz., the prevalence of fogs.

Lieutenant Shortland says, that "in foggy weather the harbour (Whitehaven) is difficult to approach, especially to a stranger, as the soundings in shore are very irregular, and I have not been able to learn any good indications of its vicinity to be gathered from the lead, so as to render its approach by that means certain; and Torbay, its immediate neighbour to the westward, is a dangerous place to get into.

"From the fishermen and small coasters I understand, the currents round the point are uncertain, and generally depend upon the wind, though the prevailing current is to the westward.

"I experienced this current in a boat when I visited the outer break; it was then setting to the westward, at the rate of one mile and a half per hour at least. I also perceived vessels in the offing setting rapidly in the same direction: the breeze was from the eastward, and light, though it had previously blown hard from the same point.

"We also on our passage from Halifax to Canseau, during a fog, with the wind from the south-west, experienced an easterly current; but the land once made, the harbour is easily attained, especially by a steamer."

This can scarcely be considered a favourable report of its advantages as a harbour intended for the great Atlantic terminus.

Accommodation and safety for a fleet of merchantmen could not be expected there, as is to be found at Halifax.

To make it a safe approach, Lieutenant Shortland continues thus:

"A judicious arrangement of fog-signals and lighthouses with buoys, on the principal dangers, and a good survey with the sea soundings well laid down, would make the approach in the night, or during fogs, attended with small danger to a careful seaman."

One of the undoubted results of the railway will be to make Halifax, if it be made, as it ought to be, the Atlantic terminus, the great emporium of trade for the British provinces and the Far West.

Whitehaven has not the capacity for this, and in winter it is evidently dangerous for sailing-vessels; and the selection of it as a terminus would be to exclude Halifax altogether, or to compel the formation of a branch railway of 90 miles in length, in addition to 57 miles of trunk railway.

It involves also the necessity of making expensive arrangements; lighthouses must be built, depôts for the supply of the steamers must be made, fortifications must be erected, and accommodation for a garrison provided. For the terminus of a great line of railway would need protection in time of war.

At present there are only a few fishermen's huts.

The probable saving of 10 hours of time in an ocean voyage, which varies even with the Cunard steamers, from 9 to 18 days*, is not of such all-absorbing magnitude as to entail, by the choice of the terminus, such a fearful amount of extra expense and inconvenience to a whole province.

At a more advanced period, perhaps, when the provinces have attained all the prosperity they have a right to expect from this and other great works, which would follow as surely as effect follows cause, then it may be time to consider the propriety of making a branch to Whitehaven.

Its selection now as the terminus would most materially affect the receipts to be expected from the traffic.

Whitehaven, therefore, with its longer and more expensive line of railway, full of engineering difficulties, passing for miles through a district of country, rocky, barren, and unfavourable for agriculture, benefiting a comparatively small proportion of the inhabitants, to the exclusion of the capital and the greatest amount of the province, or else involving the necessity of making a branch line of 90 miles in length, is decidedly recommended to be rejected.

And the city and harbour of Halifax (one of the finest in the world) is recommended to be selected as the Atlantic terminus for the proposed line of railway.

That part of the direct route (Nos. 3 and 4), viz., the line from the Bend of Petitcodiac by Boistown to the Restigouche and the St. Lawrence, crossing the range of New Brunswick mountains, having to surmount two summit levels of 1216 and 920 feet, causing heavy grades, and increasing materially the cost of transport; passing through a totally unsettled and wilderness country; involving greater difficulties in the transport of the materials necessary for its construction, and in supplying food to the labourers engaged in its formation; excluding the towns and settlements on the Gulf shore, and so preventing the development of the vast resources of the country to be derived from the fisheries; and also inflicting a serious loss to the interests of the main line, and to the intended branch to the city of St. John, in New Brunswick, is, notwithstanding its one great advantage of diminished distance, recommended most strongly to be rejected.

And the route No. 2, from Halifax to Truro, at the head of the Bay of Fundy, passing over the Cobequid Hills, and on or near to Amherst and Bay Verte, crossing from thence over to the rivers Richibucto and Miramichi above the flow of the tide, so as not to interfere with their navigation; then by the valley of the north-west Miramichi and Nipisiguit River to Bathurst; then along the shore of the Bay Chaleurs to the Restigouche River; then by the valley of the Metapediac, over to, or near to, the river St. Lawrence; then by the route as shown in the General Plan, No. 1, along the banks of the St. Lawrence to Rivière du Loup, and from thence continued through either the second or third concessions along the river until it approaches Point Levi, is recommended as the best direction for the proposed trunk line of railway from an eastern port in Nova Scotia, through New Brunswick, to Quebec.

It combines in the greatest degree the following important points:—

1st. The immediate prospect of direct, as well as the greatest amount of remuneration for the expenditure to be incurred; the opening up of a large field for provincial improvements for the settlement of emigrants, and by affording the opportunity (in addition to internal) of external communication, by means of the Gulf of St. Lawrence and the Bay Chaleurs, it will tend to develop in the highest degree the commerce and the fisheries of the province of New Brunswick.

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* In this present year (1851) it would be more correct to say 9 to 13 days, steamers of greater size and power having been introduced.

2nd. Passing along the sea-coast for a great distance, and capable of being approached at several points, by bays or navigable rivers, it possesses the greatest facilities for construction, tending to reduce the expense, and by its more favourable grades also to the cost of working and subsequent maintenance.

3rd. By passing over a less elevated country, and at the least distance from the sea, there will be less interruption to be apprehended from climate, whilst the more favourable grades will increase the efficiency and rapidity of intercourse.

4th. Passing at the greatest possible distance from the United States, it possesses, in the highest degree, the advantage to be derived from that circumstance of the security from attack in the case of hostilities.

The best general direction for the proposed trunk line of railway being admitted to be that of route No. 2, viz., the Halifax and Eastern or Bay Chaleurs route, some additional remarks may be made upon its peculiar advantages, as well as upon the few engineering difficulties which occur, and in explanation of the plans and sections forwarded.

The details of the line are given in the Appendix, No. 1. The plans referred to are the General Plan, No. 1, the Model Map, No. 2 (which should be stretched out on the floor to be properly viewed), and the book containing 16 exploratory sheets of plans and sections, which relate exclusively to this line.

The city of Halifax is situated on the western side of the harbour, whilst the best site for the terminus is on the opposite shore, at Dartmouth.

The distance to Quebec from the latter will be four miles shorter than from the former; and one great advantage is, that its shore line is as yet comparatively free from wharves and commercial establishments, and an extensive terminus can be formed there at less expense and inconvenience than on the Halifax side, where the Government dockyard and private establishments would interfere materially in the selection of a good site for it.

At Dartmouth it is expected that vessels entering the harbour will be able to unload at the railway premises, or probably into the railway cars, whilst an equally good terminus is to be had at Point Levi, opposite to Quebec. The same railway cars, loaded from the ships in harbour at Halifax, will thus, after running an uninterrpted course for 635 miles, be delivered of their contents into the boats, if not into the holds of vessels in the river St. Lawrence. The same can, of course, be done from the river St. Lawrence to the vessels waiting in Halifax harbour.

Such an uninterrupted length of railway, with such•facilities at its termini, will be, it is believed, unequalled in the world.

In the transmission of goods and merchandise this will be a most favourable point in competing with rival lines. The American Railways, especially along the Atlantic States, are constantly interrupted, and passengers have to transfer themselves not only from cars to steam-boats, but sometimes from one set of carriages to another set, in waiting for them on opposite banks of a river.

In Nova Scotia the passage of the Cobequid Hills cannot be effected without heavy grades of 1 in 79 and 1 in 85; but as these occur, the one ascending and the other immediately descending, and only for 10 miles, the inconvenience can be easily got over by affording an assistant engine for the goods' trains at that part. No engineering difficulties are expected to occur from this up to the Restigouche River.

It is necessary, however, to make some remark in reference to the sections shown in the Book, Exploratory, sheet 6 and 7, comprising that part of New Brunswick lying between Shediac and the north-west Miramichi.

The whole of this portion of the country is believed to be generally low and flat, with occasional undulations. The section run through it in the previous season of 1846, towards Boistown, confirmed this impression.

Its exploration and examination, therefore, was left to the last, and it was not until the really formidable-looking obstacles had been explored, and successfully got over, that the attention of the parties was turned to it.

As at this time the season was rapidly closing, the exploring parties were directed to cut straight lines through it, as the best means of obtaining the general altitudes and a knowledge of the country. No attempt was made to contour the hills. The sections, therefore, in these two sheets are not grades for the railway, but of the ground passed over by the straight lines. With the exception of the immediate banks of the St. Lawrence, this is expected to prove one of the easiest portions of the line.

When the line reaches the mouth of Eel River, it cannot proceed direct on to Dalhousie, but must turn off up the valley of that river.

Two courses are afterwards open to it, one to turn off through a valley, by which it can soon gain the Restigouche, the other to proceed on to the head waters of the Eel River, and then turn down to that river. Which is the best of these two routes can be better determined when the detailed surveys of the route are made.

The most formidable point of the line is next to be mentioned; this is the passage up the Metapediac Valley.

The hills on both sides are high and steep, and come down either on the one side or the other, pretty close to the river's bank, and involves the necessity (in order to avoid curves of very small radius) of changing frequently from one side to the other. The rock, too, is slaty and hard. From this cause, 20 miles of this valley will prove expensive, but the grades will be very easy.

About 14 bridges, of an average length of 120 to 150 yards, will be required up this valley. There is also a bridge of 2000 feet long, mentioned in the detailed report as necessary to cross the Miramichi River.

But bridging in this country is not the same formidable affair that it is in England.

The rivers are nearly always shallow, and the materials, wood and stone, are close at hand.

The bridges in the United States, on the best lines, are built of wood on the truss-work principle, with stone piers and abutments.

On the Boston and Albany lines, and on many others in the New England States, the bridge generally used and approved of is known as "Howe's Patent Truss Bridge."

The cost of this kind of bridge, as furnished by the parties who have purchasd the patent, is as follows:—

			Dollars.			£	s.	d.	
For spans of	60 feet,	single track,	11	per foot	=	2	5	10	sterling.
„	100	„	18	„		3	15	0	„
„	140	„	21	„		4	7	6	„
„	180	„	27	„		5	12	6	„
„	200	„	30	„		6	5	0	„

The cost for double track would be about 55 per cent. additional.

The price includes the whole of the superstructure ready for the rails, but not the piers and abutments.

The bridge over the Connecticut River, at Springfield, is built on this principle; it has seven spans of 180 feet each, and the sill of the bridge is 30 feet above low water. On other lines the same kind of bridge is used, but no iron-work is permitted (the unequal expansion and contraction of this metal is objected to), and the addition of an arch is introduced.

A bridge built on this principle on the Reading Railroad, 1800 feet long, cost 40,000 dollars, equivalent to 8330*l*. sterling.

Soon after passing the valley of the Metapediac, the great obstacle of the St. Lawrence chain of mountains is got over, and the line may range away towards Quebec; having, however, occasionally a river or ravine to cross, whose passage requires consideration.

At the Trois Pistoles the stream, in the course of ages, has worn out a very awkward and deep ravine. The bank on one side is generally steep and abrupt, whilst that on the opposite is low, and sloping away back for a long distance, before it again reaches the height of the table land.

The most favourable site for crossing it occurs at about 11 miles from the St. Lawrence, where the two banks become nearer to each other, and are more equal in height.

At this point the breadth of the stream is 100 feet at bottom. The width between the banks at top 500, and the depth is nearly 150 feet. The banks are rocky. Though formidable it is by no means impracticable.

On the New York and Erie Railway there is a bridge whose roadway is 170 feet above the bottom of the ravine, which it crosses by one span of 275 feet. Its cost was 5200*l*.

From Rivière du Loup to Quebec the railway might, but for the snow, be carried almost at a surface level.

Through the whole of New Brunswick, for 234 miles, and through Lower Canada as far as Rivière du Loup, 167 miles, there will be found along the line abundance of timber and stone (including limestone) of the best quality for building purposes. There will be found also, in New Brunswick more especially, abundance of gravel for the superstructure.

In Nova Scotia the railway will have to pass, with but one little exception, through land which has been sold or granted away to individuals. The exception will be the other way in New Brunswick. It will be seen, on reference to the model map, that it approaches the settlements between Bay Verte and Shediac, and skirts along the Bay Chaleurs.

In Canada, from the mouth of the Metapediac to the Trois Pistoles, it runs through still ungranted land. But for the last 110 miles between Rivière du Loup it runs through a densely-settled country.

Until the detailed surveys are made, and the precise location of the line marked on the ground, it will be impossible to state precisely the exact number of miles it will pass through Crown land.

If the following estimate be taken, it will not be much out:—

In Nova Scotia	15 miles.
New Brunswick	200 ,,
Canada	160 ,,
Total	375 ,,

The following synopsis will show approximately the quantities of ungranted land in the counties through which the line passes:—

	Acres.	
In Nova Scotia.		
Halifax County	780,000	
Colchester	120,000	
Cumberland	180,000	
		1,080,000
In New Brunswick.		
Westmoreland County	301,000	
Kent	640,000	
Northumberland	1,993,000	
Gloucester	704,000	
Restigouche	1,109,000	
		4,747,000
In Canada.		
Bonaventure	2,000,000	
Rimouski	5,000,000	
Kamouraska	500,000	
L'Islet	600,000	
Bellechasse	500,000	
		8,600,000
General total		14,427,000

The land for the railway will have to be purchased in Nova Scotia for nearly its whole course, and in Canada for the 110 miles mentioned.

The latter, however, it is expected, will cost very little more than the expense which it would be necessary to incur in cleaning, getting out the stumps, and preparing the wild lands for the railroad.

No part of the line will ever be at any great distance from Crown lands; but it will be a question of detail for this part, as well as for the Nova Scotia section, whether it will be more advantageous to cut and convey from them the timber and materials required, or purchase them.

The direction of the proposed line being determined upon, the next points which present themselves for consideration are, the character of the road and method of construction.

In the first instance, it is considered that one line of rails will be sufficient; but in taking ground for the railways and stations, and wherever the line passes, regard should be paid always to the prospect of its being made at some future time a double track. And in the anticipation of a heavy traffic, which there is a fair prospect of soon passing along it, and with a view to ultimate economy, as well as the saving of much inconvenience, it is recommended that the road (being intended for the great trunk line) should be constructed at once in a substantial and permanent manner, with a good heavy rail, capable of bearing high rates of speed for passenger trains.

On all the principal lines of railway in the United States, the flat iron bar is everywhere being discarded, and the H, or T rail, generally of 56 lbs. to the yard, is being substituted for it.

On several of the lines, also, a double track is being made, and the works constructed are of a more permanent character than formerly.

Much has been said in praise of the cheap method of making railways in America, and the advantages to be derived from it in a new country.

As an example of this system, and its practical results, the Utica and Syracuse Railway may be here quoted.

This road is 53 miles in length, and forms part of the Great Western line, connecting Albany, on the Hudson River, with Buffalo, on Lake Erie—one of the principal lines in the country.

In its construction more than a usual amount of timber was used. For a considerable portion of its length (upwards of 19 miles) it passes through a deep swamp. Piles were driven into this to support a long-continued trestle-bridge, over which the railway track was carried upon longitudinal bearers.

For the other 33 miles the grading was made in the usual manner, by excavations and embankments; but the superstructure was of wood.

Upon the grading in the direction of its length, a small trench was excavated, and a sill of wood was firmly bedded in it. Where the sills abutted end to end, they were supported by a piece of wood of the same section laid beneath them. At right angles to, and upon the upper surfaces of the sills, were spiked cross-ties; and again, at right angles to the cross-ties, and immediately over the sills, were laid the longitudinal wood-bearers, to which the iron plates were firmly spiked. The centre of the rail and sill were in the same vertical plane.

Thus everything was done for economy, as much wood as possible being used. This railway, for its construction and equipment, cost on an average only 3600*l.* per mile.

It was thought worthy, in 1843, to publish an account of it in London, and it forms the chief subject of a volume thus entitled, "Ensamples of Railway Making; which, although not of English Practice, are submitted to the Civil Engineer and the British and Irish Public."

The following Report is extracted from the Annual Statement of the Secretary of State to the Assembly of the State of New York, dated 4th March, 1847:—

"The Syracuse and Utica Railroad has been opened for the transportation of passengers for the last eight years.

"The Company, having determined to relay the road with an iron rail of the most improved form, have contracted for a considerable portion of the iron necessary, and are proceeding with the intention of laying a substantial structure, adequate to the proper performance of the business required.

	Dolls.	Cts.
"The present wood structure has cost the Company . .	417,075	55
"The iron now laid thereon is the flat bar, and will be useless, and therefore will be sold. It is hoped that there may be derived from the sale of it	80,000	00
"Leaving the sum of . .	337,075	55

which has been expended for the cost of the wood structure; which, in addition to a large annual amount for repairs, will be practically worn out, sunk, and gone, when the new structure is laid and used. The new structure, it is supposed, will cost about the same as the former, towards which, it is hoped, the old iron will pay as above, 80,000 dollars, leaving the sum of about 300,000 dollars to be raised by the Company on its credit.

"This will, when paid, reimburse the capital of the Company for the equivalent amount which has been appropriated to the worn-out structure. In addition to the cost of the new structure, there will be required a considerable sum for new engines, cars, &c. The demand upon the Company for the transportation of property at the close of the canal, has entirely exceeded its capacity to do this business. Property destined for sale in the eastern markets in large quantities, was stopped at most points upon the line of railroad contiguous to the canal. Being practically confined to the winter months in this branch of business, it cannot be expected that the Company could provide a supply of cars for this sudden and extraordinary demand, when they must stand idle and go to waste during two-thirds of the year.

"When the road shall be relaid with the proposed iron rail, the public will require that the trains shall be run with increased speed. In relation to this subject, it is deemed proper to refer to the following suggestions contained in the report of this Company made last year:—

"Very great embarrassment is experienced from the fact that cattle are allowed to run at large, and to impede and so often delay trains as at present. It is a serious matter, and unless more care shall be bestowed by the owners in restraining them, either at their own suggestion, or in pursuance of some proper law to be passed, it will be found very difficult to make good time upon this line. A part of our business must be always done in the night, and it is then we experience the great hazard. The trains are frequently thrown off by them, and the danger to the persons in charge, and to the passengers, is imminent. The owners always insist on pay for their animals destroyed, without reflecting upon the great damage that they cause to the property of the Company, and the more fearful injury that might ensue to passengers. If the owners will not take care of them, it is impossible to keep them off. In Massachusetts much less difficulty in this respect is experienced; for there, it is believed, a penalty is incurred by the owner of domestic animals that go upon the railroad. Our business is conducted with all possible care in this respect, and the enginemen suitably feel the risk of life or limb (which to them is almost as important) that they incur from the growing evil.

"A very proper law in this State has guarded the public and the Company against direct wanton injury to the trains by individuals. It is submitted, that negligence in allowing animals to run upon the railroads should be prevented by some suitable restraints."

Some of the inconveniences arising from a cheap railway may be learnt from this report.

At this time the total amount spent upon its construction appears from the same report to have been 1,098,940 dollars, equivalent to 4520*l.* sterling per mile.

The new superstructure, it was supposed, would cost about the same as the former, viz., 417,075 dollars, or about 1640*l.* sterling additional, which will make the price of this railway, when completed as intended, 5960*l.* per mile.

In other parts of the States, where these trestle-bridge or skeleton railways have been made, instances have been known of the locomotive slipping down between the rails, which have warped outwards.

With a view therefore to ultimate economy, and to save inconvenience and interruption to the traffic when once established, it is most strongly recommended that the line, whenever commenced, shall be at once properly and efficiently made.

In determining the form of the road, it is necessary to bear in view that it will pass through a country everywhere liable to be obstructed by heavy falls of snow. It does not appear, however, from the results of inquiries made in the United States, that anything beyond inconvenience, and some additional expense in the cost of working the line, is to be apprehended from this cause.

The railway from Boston to Albany, which crosses the range of mountains between the Connecticut and Hudson Rivers, attaining upon them an elevation of upwards of 1400 feet above the sea, to which it ascends by a grade of about 80 feet per mile for 13 miles, traverses a country subjected to the same sort of winter as the British North-American provinces.

The average depth of snow in the woods is from 3 to 4 feet, which is not much less than it is in the woods of New Brunswick and Canada.

In 1843, a year remarkable for the great number of snow-storms which occurred, there were 63 falls of snow; but the traffic was not interrupted to any very serious extent, not more than two or three trips.

To keep the roads clear, two descriptions of snow-ploughs are used, one for the double track, and another for the single. In the former the *share* of the plough travels immediately over the inner rail, throwing the snow outwards from the track. It is first used on one track, and then runs back upon the other.

In the single line the ploughshare travels in the centre of the track, throwing the snow off at once upon both sides.

For the double track the snow-plough weighs from 5 to 6 tons, and costs about 125*l.* For the single track it is somewhat lighter.

The plough requires generally, when run without a train, two engines of 20 tons each, or with a train, three engines.

When the fall of snow does not exceed a few inches, the small plough, always fixed in front of the engine, consisting of an open frame-work projecting about 5 feet in front, and called a "*cow-scraper*," is found, when cased over, to be sufficient to clear the line. When the fall is deeper, the plough is used immediately after the snow has ceased to fall.

It can be propelled by three 20-ton engines through 3 feet of newly-fallen snow at the rate of six miles an hour.

If the fall does not exceed two feet, it can travel at the rate of 15 miles an hour.

The drifts through which it is propelled are sometimes 15 feet deep, and from 200 to 300 feet long, and at others 8 or 10 feet deep, and from a quarter to half-a-mile in length.

The line of railway is marked in divisions of about eight miles, to each of which eight or ten men are allotted, who pass along the line each day with small hand-ploughs, picks, &c., clearing away the snow and ice which the trains collect and harden between the rails and the roadway.

It is found that the freezing of the snow or rain upon the rails does not impede the heavy engines, as the weight of the forward wheels is sufficient to break it, and enable the driving wheels to bite.

Whenever, from local causes, the snow is found to drift on the line of railway, snow fences are erected, which are found very effectual. They are simple board fences, from 10 to 15 feet high, placed from 10 to 20 feet back from the roadway.

In wet weather the rails become very slippery; but the difficulty is overcome, and the wheels enabled to bite upon the steep gradients by the use of sand-boxes, which are fixed in front of the engine and immediately over the rails. These can be opened at pleasure by the engine-driver, and the sand is used wherever necessary.

The means thus successfully adopted to overcome the obstacles arising from ice and snow are employed much in the same way upon all the railways which are exposed to them.

In the year 1847 the expense incurred under this head (removing ice and snow) upon the western railroad in Massachusetts, was, according to the official return, 2763 dollars, equivalent to 575*l.* sterling.

Upon many of the other lines expenses under the same head are returned, but very much smaller in amount.

In places where the rails are not raised above the general level of the country, much greater difficulty is experienced in keeping the lines clear of snow than in parts where there are embankments.

From the foregoing it does not appear, therefore, that snow need be considered an insurmountable obstacle to the formation of a line of railway from Halifax to Quebec.

To obviate, as much as possible, the liability to interruption from this cause, it is recommended that in the construction of the line, it be adopted as a principle, that the top of the iron rail be kept as high as the average depth of snow in the country through which the line passes.

In Nova Scotia this will require probably an embankment of two feet high, gradually increasing as it proceeds northward to the St. Lawrence, and along the flat open country on its banks, to five or even six feet.

The whole of that part of British North America through which this line is intended to be run, being as yet free from railways, the choice of gauge is clear and open.

Without entering into and quoting the arguments which have been adduced in favour of the broad or narrow gauge of England, as it is more a question of detail than otherwise, it will be deemed sufficient for the present report to recommend an intermediate gauge. Probably five feet six inches will be the most suitable, as combining the greatest amount of practical utility with the least amount of increased expenditure.

With the object of proceeding on to the consideration of expense of construction, the proposed trunk line will be supposed to have a single track, with one-tenth additional for side lines and turn outs, to have a rail 65 lbs. to the yard, supported upon longitudinal sleepers, with cross-ties, similar to the rail used upon the London and Croydon line; the wood to be prepared according to Payne's process, to have a gauge of five feet six inches, and as a principle, the top of the rails to be kept above the level of the surface of the ground, at a height equal to the average depth of the snow. For the best information as to the cost of making such a railway, reference must be made to the works of a similar character in the United States.

At about the close of the year 1847, there were in that country nearly 5800 miles of railway completed or in progress. The average cost for those having a single track has been estimated at 22,000 dollars, equivalent to 4166*l.* sterling per mile. For the double track, 32,000 dollars, or 6666*l.* sterling per mile.

But the extreme differences which are to be observed in the cost of construction in the various States are so great, ranging from 1600*l.* up to 24,000*l.* per mile, that no criterion can be established from averages obtained from such discordant data.

The State of Massachusetts affords the best materials for accurate information.

All the railroad corporations are by law obliged to make annual returns to the Legislature, and very valuable statistical information is thereby obtained upon railway affairs.

From the official reports for the year 1847, the following table (see next page) has been compiled.

This table comprises, with the exception of about 50 miles, upon which there occur some doubts as to what the account precisely embraces, the whole of the railroads at present completed in the State of Massachusetts. The table shows 683½ miles of railway, including branches, which have cost in their construction and equipment 31,675,946 dollars, or 6,599,155*l.* sterling.

There are 146 miles of double track. They have been taken at so much additional single track. A double track would not cost exactly twice that of a single one in its construction; but as these lines were made originally only with single tracks, and have been added to from time to time as circumstances would admit, it must have tended to increase the cost, and in calculating the average expense per mile, it is considered the result will not be much in error. The cost per mile it appears, then, has been 7950*l.* sterling.

There is no other State in the Union which presents equally good data for making an approximate estimate.

The climate and nature of the country bears also a strong resemblance to that through which the Halifax and Quebec line will pass, and in this respect the analogy of the two cases is extremely favourable.

The New York and Erie railroad, 450 miles in length, now in course of construction, will, it is supposed from the latest information, cost 6250*l.* per mile, exclusive of equipment.

The estimate for the Hudson River railroad from New York to Albany, now in progress, is for the single track 7440*l.* sterling per mile.

The estimate for the Montreal and Portland line is about 5080*l.* sterling per mile.

For the Great Western railroad, in progress in Upper Canada, the estimate for that section of the line which would most resemble the Halifax and Quebec road, is 5638*l.* per mile.

On referring to the table, it will be seen that all the lines have either the H or T rail, generally 56 lbs. to the yard.

The price of railroad iron in the States is very much greater than in England, or what it can be procured for in the British provinces. It pays a very high duty on importation into the States.

On some of the lines upwards of 15*l.* per ton for rails have been paid. In England rails can now be bought for 8*l.* or 9*l.* per ton.

The advantage which the Halifax and Quebec line will possess over the lines in the table in the respect of iron alone may be estimated at 500*l.* per mile.

RAILROADS IN THE STATE OF MASSACHUSETTS.

Name of road.	Length of road in miles.	Total cost of road and equipment.	Cost per mile.	Form of rail and lbs. per yard.	Miles of single rail.	Miles of double rail.	Dividend for 1847.	Cost per mile of single track, sterling.	Remarks.
		Dollars.	Dollars.	m. lbs.				£.	
Boston and Lowell . . .	26	1,956,719	75,258	H { 1½ 45 20 56 3¾ 63 }	None	26	8	7,830	
Boston and Maine . . .	73	3,021,172	41,385	{ H 6 m. 45 lbs. rest 45 to 60 }	68	5	9	8,069	
Boston and Providence . .	48	2,545,715	53,014	T 56 to 58	32¼	15¾	7½	8,316	
Boston and Worcester . .	{ 44½ 14 }	4,113,609	70,318	T or H 60 to 64	14	44½	8	7,583	Including branches.
Connecticut River . . .	{ 36 2 }	1,167,156	30,714	H 56 lbs.	38	None	7	6,399	Ditto.
Eastern	{ 38 20 }	2,937,206	50,641	lbs. H and chair { 57 46 }	42	16	8	8,269	Ditto.
Fall River	42	1,070,988	25,499	H 52 to 56	42	None	...	5,312	
Fitchburgh	{ 49½ 2 }	2,406,723	46,732	T 56 lbs.	46¼	5¼	10	8,835	Ditto.
Lexington and W. Cambridge	6½	221,309	34,047	56 lbs.	6½	None	...	7,093	
Nashau and Lowell . .	14¼	500,000	35,087	T 56 lbs.	1¼	13	10	3,822	
New Bedford and Taunton	{ 20 1 }	483,882	23,042	56 lbs.	21	None	8	4,800	Ditto.
Norwich and Worcester .	{ 59 7 }	2,187,249	33,140	T 56 lbs.	64¼	1¾	...	6,725	Ditto.
Old Colony	{ 37 7 }	1,636,632	37,196	H 56 lbs.	44	None	6½	7,749	Ditto.
Pittsfield and N. Adams .	19	446,353	23,492	H 56 lbs,	19	None	...	4,894	
Western	118	6,982,233	59,171	56½ to 70	99	19	...	10,617	
Total	683¾ 146¼	31,675,946	...	...	146½	...	...	7,950	Average for single tract per mile.
Single track . .	830								

When these lines were constructed, also, the demand for labour was extremely great, and wages much higher than in the present day.

The average (of 7950*l.*) derived from the table may therefore very fairly be reduced by several hundred pounds.

The Halifax and Quebec line will have also many advantages which the American lines had not.

The land for the greater portion of the road will not have to be purchased. Timber and stone will be had nearly along the whole line for the labour of cutting and quarrying.

Judging, then, from the analogy afforded by similar, or nearly similar lines, in the neighbouring States—giving due weight to the considerations which have a tendency to modify the cost in the particular case of the Halifax and Quebec line, and forming the best estimate to be derived from the data obtained upon the exploratory survey, which under the circumstances of a perfectly new country, only recently explored, and still covered with a dense forest, is all that can in the first instance be done—it is considered that if the sum of 7000*l.* sterling per mile be assumed as the probable cost of the proposed line, it will not be far from the correct amount.

The total distance from Halifax to Quebec will be about 635 miles.

635 miles at 7000*l.* per mile will be	£4,445,000
Add one-tenth for contingencies	444,500
	£4,889,500

Or, in round numbers, 5,000,000*l.*

It is estimated, therefore, that the cost for construction and equipment of the proposed trunk line, from Halifax, through New Brunswick, to Quebec, will amount to 5,000,000*l.* sterling.

The question which presents itself next for consideration is a very important one, namely, the probable returns for such an expenditure.

The information to be afforded on this head can only be derived in a very general way, from a consideration of the present population and resources of the three provinces.

The direct communication between the two termini, Halifax and Quebec, is of a very limited nature.

By land, it is confined almost to the conveyance of the mails. Passengers proceed generally by way of the United States.

By sea, in 1847, the communication was by 17 vessels, which arrived at Quebec, having a tonnage of 1257, and 18 departed from that port for Halifax whose tonnage amounted to 1386 tons.

This amount of intercourse does not at the first view appear encouraging to expected receipts; but when it is made to appear that this limited intercourse arises entirely from the want of good means of intercommunication, such as would be afforded by the proposed railway, it becomes a strong argument in favour of making the line rather than against it.

The communication of the provinces with each other is cramped and restricted beyond measure by the same want.

By sea the amount of intercourse may be judged of by the return given in Appendix No. 6, furnished by the Quebec Board of Trade.

The chief elements which enter into, and upon which depends, the success of every railway enterprise, are population, agriculture, and commerce.

At the extremities of the line, and for some miles along the St. Lawrence, there is an abundant population. External commerce there is in an eminent degree. In that of agriculture its deficiency is great at present, but as there are millions of acres of good productive land only waiting for the hands necessary to cultivate them, and the means of access to which will be afforded by the railway, this very circumstance may be made to conduce to the advantage of the line, and pay a large portion of the expense of its construction.

The population of Halifax (the Atlantic terminus) is estimated at 25,000 souls. It is the capital of the province—the seat of government—and its commerce extensive. The value of its imports and exports is estimated at 2,500,000*l.*

The city of Quebec, the other terminus, according to the census of 1844, contained (including the county, which is not given separately) 45,000 persons.

But this city derives additional importance from its being the one great shipping port and outlet for all Canada. By its port passes the whole trade of that province. It may be regarded as the focus of commerce for a million and a half of souls. The value of the imports and exports together may be estimated at 5,500,000*l.* sterling, giving employment to a very great amount of shipping.

This immense trade is of necessity crowded into six months, the navigation of the St. Lawrence being closed for the remainder of the year.

In addition to these two great termini there are lying on each side of the line two most important tributaries, viz., the city of St. John and Prince Edward Island. The former with a population in city and county together of nearly 44,000 persons, with a commerce of the value of 1,800,000*l.* in exports and imports, giving employment also to a great amount of shipping. The latter with a population of 50,000, engaged principally in agriculture and the fisheries. The exports and imports of this island are about 200,000*l.* annually.

Between the city of Quebec and the River Metis there are, settled along the south bank of the St. Lawrence, 75,000 inhabitants all engaged in agriculture. These people are French Canadians, and almost every family has a small farm and homestead.

A striking peculiarity of these farms is their elongated shape, the length being generally 30 times that of the breadth ; oftentimes a greater disproportion exists. The houses and farm-buildings are always built at one extremity, that which adjoins the road dividing one set of concessions from another. There are generally three or four lines of houses and roads running thus along the St. Lawrence.

The effect produced by this manner of parcelling out the land and building has been to form what can only be compared to one long and continued village for 200 miles.

For the first 100 miles out of Quebec, as far nearly as the Rivière du Loup, the proposed line of railway will run through the centre of this extended village, and with a train of moderate length, the last carriage will scarcely have cleared the door of one house before the engine will be opposite another. For the second 100 miles it will leave these concessions and farms a little on one side, but still within reach. A more favourable disposition of a population (comprised of small farmers) for contributing to the way traffic of a railroad could scarcely have been devised.

In the country lying between the Restigouche River and Halifax, the inhabitants who will be near to the railroad will amount to about 100,000; making the population, either upon or near to the line, including the two termini, 250,000 persons. But if the total population be taken within the area, which will be benefited by and become contributors to the line, then it may be estimated at not less than 400,000 souls.

In a report of the Directors, made upon the New York and Erie Railroad in 1843, when the question of proceeding with that line was under consideration, one of the data upon which its future receipts was calculated was derived from population and relative distance. And using the data obtained from the working of one portion which had been completed and was in operation, it was calculated that 531,000 persons on a line of 425 miles in length, would return in net earnings to the railway 1,343,500 dollars, or 2½ dollars nearly per head, equivalent to 10*s.* sterling. As the railroad is not yet completed, the true result cannot yet be seen.

The net earnings of the railroads in Massachusetts for the year 1847 were 2,290,000 dollars. The population of that State, over whose area railways are everywhere extended, and the whole of which may therefore be considered as tributary to them, being at the time about 800,000. This gives 2¾ dollars per head, equivalent to 11*s.*, or the same result nearly.

Applying the same ratio (of 10*s.* per head) to the 400,000 inhabitants who are within the area and likely to become tributaries to the Quebec and Halifax Railway, it would give 200,000*l.* as its probable revenue.

The great staple of trade of New Brunswick is its timber. For this all-absorbing pursuit the inhabitants neglect agriculture, and instead of raising their own supplies, they import provisions in large quantities from Canada and the United States. In the year 1846, New Brunswick paid to the latter for provisions alone 216,000*l.* sterling, whilst, in return, the United States only took from them 11,000*l.* in coals and fish.

Of Nova Scotia the great staples are timber and the products of the fisheries. The inhabitants import provisions also largely.

Canada is an exporting country, and capable of supplying the demands of both.

In the winter of 1847-8, the price of flour at Halifax and St. John was at 40*s.* the barrel, and it was being imported from the chief ports in the United States, even from as far as New Orleans, in the Gulf of Mexico. At the same time, at Quebec the price of flour was only 25*s.* per barrel. A very great difference, which, had the railroad been in existence, would not have occurred.

Another great source of revenue likely to be developed by the railway is that of coals, to be derived from the Great Cumberland Field.

Quebec and the upper country would, no doubt, take large quantities for their own consumption. Halifax the same for itself, and also for exportation to the United States.

Considerable returns would arise from the fisheries and from the products of the forest lying contiguous to the line, which would find their way by it to the shipping ports.

The country through which the road will pass possesses, therefore, in itself, elements which, when fully developed, cannot fail to realize large receipts.

But there are, exclusive of these, other and highly important sources for productive revenue.

Halifax may be considered to be the nearest great seaport to Europe.

Passengers travelling between England and the Canadas would adopt this railway as the shortest and best line which they could take. Emigrants would do the same.

The mails, troops, munitions of war, commissariat supplies, and all public stores, would naturally pass by it, as the safest, speediest, and cheapest means of conveyance.

If a straight line be drawn from Cape Clear, in Ireland, to New York, it will cut through or pass close to Halifax.

The latter is therefore on the direct route; and as the sea voyage across the Atlantic to New York may be shortened by three days nearly, in steamers, it is not improbable that on that account, when the branch railroad to St. John is completed, and other lines to connect on with those in the United States, the whole or the greatest portion of the passenger traffic between the Old and New World would pass through Halifax, and over a great section of the proposed railroad.

But the great object for the railway to attain, and which, if it should be able to accomplish, its capability to pay the interest of the capital expended would be undoubted, is to supersede the long and dangerous passage to Quebec by the Gulf of St. Lawrence.

To make two voyages in a season vessels are obliged to leave England earlier, and encounter the dangers of the ice in the Gulf, much sooner than it is safe or prudent for them to do.

The loss of life and property which has occurred from this cause, and returning late in the autumn, has been enormous. It cannot be ascertained, but probably it would have more than paid for the railway.

An opinion may, however, be formed of it from the rates of insurance, which in the spring and autumn are as high as 10 per cent.—a much higher rate than to any other part of the world.

The navigation of the St. Lawrence is closed for about six months of every year. During the whole of this period all the produce of the country is locked up, and necessarily lies unproductive on the hands of the holders.

The surplus agricultural produce of the year cannot be got ready to be shipped in the season it is produced. In the winter of 1846-7, it has been stated, on good authority, that 500,000 barrels of flour were detained in Montreal at the time when famine was raging in Ireland. As soon as the season opened, there was such a demand for shipping to carry provisions, that the ordinary course of the timber trade was deranged by it.

All this would have been prevented had the railway been then in existence.

For six months in the year, then, the St. Lawrence would cease to be a competitor with the railway, and large quantities of produce would be certain to be forwarded by it.

For the other six months of the year it would have also the following strong claims to preference:—rapidity of transport; the saving of heavy insurance; cheaper rate of freight from Halifax; vessels engaged in the Canadian trade could make three voyages to Halifax for two to Quebec.

The trade which is now crowded into six months, to the great inconvenience of every one concerned, rendering large stocks necessary to be kept on hand, would be diffused equally over the whole year.

It is most probable that these advantages will be found so great that only the bulky and weighty articles of commerce, such as the very heavy timber and a few other goods, will continue to be sent round by the Gulf of St. Lawrence.

If such should prove to be the case, then the proposed railway would have as much, or perhaps more, traffic than a single track could accommodate.

The cost of transportation, it is calculated, will not be too high on this line to admit of the above results being realized; and in that case, more especially if the capital can be raised at a moderate rate of interest, it is considered highly probable that it will, even in a commercial point of view, be a profitable undertaking.

From evidence given to the Gauge Commissioners in England, it appears that the cost of transport for goods on the undermentioned lines of railway was as follows:—

Great Western	·06	of a penny per ton per mile.
Grand Junction	·13	" "
Birmingham and Gloucester .	·09	" "
South Western	·10	" "
London and Birmingham . .	·12	" "
	5)·50	
	·10	Average per ton per mile.

This is supposed to be gross weight, including carriages, &c.

One-fifth of a penny per mile per ton will be a liberal allowance for the net weight.

From a very carefully-prepared document, extracted from a Report of the Commissioners appointed in 1846 by the Legislature of the State of New York, to locate certain portions of the New York and Erie Railroad, it appears that the cost of motive power on some of the principal railroads in the United States was 40 cents per train per mile, equivalent to 1*s*. 8*d*. sterling.

With the expected grades on the Halifax and Quebec line, it is calculated that an engine of good power, having the assistance of an extra engine for 25 miles of the distance, will convey 100 tons of goods at a moderate speed of 8 to 10 miles an hour over the whole line.

The total cost per train would then be—

	£.	*s*.	*d*.
635 miles, at 1*s*. 8*d*. per mile	52	18	4
25 miles, at 1*s*. 8*d*. for extra engine .	2	1	8
Total for 100 tons . . .	£55	0	0

or 11*s*. per ton for the whole distance. Equal to ·207 d. per ton per mile, the same nearly as the average on the English railways.

At this rate the actual cost of carrying a barrel of flour from Quebec to Halifax will be only 1*s*. 1*d*.; and if it be doubled, to pay interest on capital, then 2*s*. 2*d*. might be the price charged for its conveyance*.

The freight of flour from Quebec to England may be taken at 5*s*. per barrel; from Halifax, at 3*s*.

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* This estimate has been considered too low.

In the *British North American*—a newspaper published at Halifax, of the 20th November, 1850—was the following paragraph:—

"The transportation of a barrel of flour from Ogdensburgh to Boston is 51 cents, exclusive of storage."

That is 2*s*. 1½*d*. for a distance of about 400 miles, by railway.

In England, on the North Western, coals are carried at ¾*d*. per ton per mile.

On the Great Northern ½*d*. per ton per mile.

On Erie and New York railroad, 465 miles long, flour is carried at 2*s*. 2*d*. per barrel.

The difference in freight would therefore pay its transit by railway, and the difference in the rates of insurance would be to the profit of the owner; and the voyage being shorter, there would be less risk of its arrival in the market in a heated or deteriorated condition.

Provisions, and all other articles whose value is great in proportion to their bulk, would be as advantageously forwarded by this route.

It is fully expected, therefore, that the railway will be able to compete successfully with shipping in the St. Lawrence even during the summer season.

But there is still another great and important source from which traffic may be expected, viz., from those vast and extensive regions in the Far West, round the Lakes Huron, Michigan, and Lake Superior.

By the completion of the canals along the River St. Lawrence, the produce of these lake countries now finds its way to the markets of Montreal and Quebec.

Large cargoes, consisting of upwards of 3000 barrels of flour, can now pass from their ports down to Quebec without once breaking bulk.

Already produce which found its way to New York by the circuitous route of the Mississippi and New Orleans has been diverted to the channel of the St. Lawrence.

The extent to which this will take place it is not possible yet to calculate; but there is no doubt that large quantities of produce which formerly found its way to the Atlantic ports of New York and Boston will be diverted to the St. Lawrence.

Of the enormous exports of provisions from the United States, the following will give some idea :—

	In 1846.	In 1847.
Flour, barrels . .	2,289,476	4,382,496
Wheat, bushels . .	1,613,795	4,399,951
Corn, bushels . .	1,826,068	16,326,050
Meal, barrels . .	293,720	918,066

The greatest portion, if not nearly all this immense produce, of which the above forms only a few items in the great account, was received at the Atlantic ports from the Far West. And it is for this most important and still increasing trade that Montreal and Quebec will now, by means of the St. Lawrence canals, have the most favourable chance of a successful competition with New York and Boston.

It has been calculated that the cost of transport for a barrel of flour from the Lakes to New York was 5*s.* 1*d.* sterling; to Boston 6*s.*; exclusive of charge for transhipment.

By the Quebec and Halifax line it is estimated, now that the canals are open, a barrel of flour may be delivered at Quebec for 2*s.* sterling, and carried to Halifax for 2*s.* 2*d.*—total, 4*s.* 2*d.*

By the Montreal and Portland, 1*s.* 8*d.* has been estimated as the price per the railway, to which, if 2*s.* more be added as freight to Montreal, the price by that line will probably be only 3*s.* 8*d.* sterling per barrel. The Montreal and Portland will have, therefore, an apparent advantage over the Quebec and Halifax line, arising from its much shorter distance. But there are some drawbacks attending it, which may cause the preference to be given to the latter notwithstanding. The line passes through the United States.

A transit duty of 2½ per cent. *ad valorem* has to be levied upon all foreign produce, and introduces the inconvenience of custom-houses and custom-house officers.

Portland is a foreign port, and is 400 miles by sea farther from England than Halifax.

It has been seen in a former part of this report, when speaking of the Utica and Syracause Railroad, how inadequate that line was to take all the traffic which was required to be forwarded by it, at the time the Erie Canal is closed.

The growing population and produce of the Western States are so gigantic, that it is probable there will be more than sufficient to employ fully both the Montreal and Portland and the Quebec and Halifax Railroads.

From the foregoing remarks it will appear, then, that although no very good or precise estimate of the returns for the expenditure of five millions sterling can be given, yet that there are very good general grounds upon which to form an opinion that ultimately, if not at once, the line will, in a commercial point of view, be a very productive one.

The Montreal and Portland, which will be the great competitor with that of the Quebec and Halifax line, is an enterprise of a purely commercial and local nature. As such, it is not likely shareholders will be contented unless they receive what they have every right to expect, a high rate of interest for the expenditure they have incurred and the risk they have encountered in the undertaking.

But with the Quebec and Halifax it is very different; the enterprise is of general interest. It concerns the prosperity and the welfare of each of the three provinces, and the honour as well as the interests of the whole British Empire may be affected by it. It is the *one* great means by which alone the power of the mother country can be brought to bear on this side of the Atlantic, and restore the balance of power now fast turning to the side of the United States.

Every new line of railway made in that country adds to their power, enabling them to concentrate their forces almost wherever they please, and by the lines, of which there are already some, and there will soon be more, reaching to their northern frontier, they can choose at their own time any point of attack on the long-extended Canadian frontier, and direct their whole strength against it.

The provinces, therefore, and the empire having such interest in the formation of the Halifax and Quebec line, it should be undertaken by them in common, as a great public work for the public weal.

If so undertaken, the provinces, supported by the credit of the mother country, could raise capital at a rate of interest which could not be done by any Company of shareholders. And if to this advantage be added the disposal, for the exclusive benefit of the railway, of a portion of the wild lands along the line, and in the immediate country which it would be the means of opening to settlement and cultivation, then it is highly probable that it would be constructed for three millions sterling.

In a former part of this report it has been estimated that there are in the counties through which this line will pass fourteen millions of acres of land yet ungranted, and therefore remaining at the disposal of the Provincial Governments.

The ordinary price of an acre of wild or uncleared land is about 2*s.* 6*d.* to 3*s.* per acre; but where public roads are made through them the value immediately increases, and it will not be considered an extravagant estimate to suppose that the land along it, or in the immediate vicinity of the railway, will be worth 1*l.* per acre.

For the construction of the Great St. Lawrence Canal, by which Canada has now the prospect of reaping such immense advantages from the trade of the western country, the Imperial Government guaranteed the interest on a loan of two millions sterling and upwards, at 4 per cent. This loan was easily raised, and a large premium per cent. was received in addition for it.

There can be little doubt that another loan of three millions sterling, at the same rate of 4 per cent. interest, could be raised upon the credit of the provincial revenues, if guaranteed by the mother country. With this amount of capital, and two millions of acres to be reserved and sold from time to time, it is conceived the railway may be made.

Upon the strength of these two millions of acres, and the loan as a basis, a large amount of notes might be issued in payment of the wages and salaries of the labourers and other persons employed on the works of the railway. They should be made receivable for taxes and Customs' duties. The amount authorized to be issued might be limited to the extent of the acres, and as these were sold, an equal amount of the notes should be cancelled.

The issue of a number of notes which would pass current over the three provinces would be conferring a great benefit upon the community at large. The currency is not the same throughout, and persons who travel from one province to another are now put to inconvenience, and have often to pay a discount upon exchanging the notes of one colonial bank for those of another. Advantage might be taken of the measure to assimilate the currency of the colonies to each other, and make it " sterling," the same as in England.

By a little arrangement, also, these notes might be made payable at the chief ports of emigration in the United Kingdom; and in that case a very great convenience would be afforded to a large class of persons on both sides of the Atlantic.

To remit small sums now requires the intervention of bankers or agents. This has the effect, upon persons resident in the settlements (and no doubt also often in towns), of preventing their sending the assistance which they otherwise would do to friends at home. Many a small note would be put up and sent in a letter, which now is never thought of for want of the convenience.

In remitting sums from Halifax to England the banks do not like to give bills at less than 60 days' sight. These notes would, therefore, become a great public benefit, and there would be no fear of their being kept in circulation almost to any amount.

Upon the loan of three millions the interest at 4 per cent. would amount to 120,000*l.* per annum.

Of this sum it may be fairly assumed that for the conveyance of the mails between Halifax and Quebec, the Post Office department would be willing to pay annually an equal amount to what is now paid for the same service. This has not been officially obtained, but there are good grounds for supposing that it is nearly 20,000*l.*

In the case, then, that beyond this the railway only paid its own working expenses, the sum of 100,000*l.* would have to be made good out of the revenues of the provinces.

The proportion of this, or of whatever sum might be deficient to pay the interest on the loan, would have to be arranged; and it may, for the sake of illustration, be supposed to be as follows :—

Nova Scotia	£20,000	Proportion	·2
New Brunswick	20,000	„	·2
Canada	30,000	„	·3
The Imperial Government	30,000	„	·3
Total	£100,000		1·0

For the proportion guaranteed by the provinces they would receive the benefits conferred by the railway in developing their resources, increasing the value of all property, promoting the sale and settlement of their wild lands, increased population, and increased revenue.

For the proportion guaranteed by the Imperial Government, all Government officers, civil or military, troops, munitions of war, supplies, &c., for public service, and emigrants, should be transported over the line at the cost price.

New Brunswick and Nova Scotia, it is understood, are most willing to guarantee the interest to the extent of their means, and in a fair proportion.

Canada having done so much already for the communications above Montreal, it is fully expected will not be backward in perfecting those below Quebec.

In the extreme case supposed above, viz., of the railway yielding no returns beyond working expenses, it is not conceived that either one of the provinces or the empire would not receive an equivalent in some other form for its direct contribution to make good the interest.

An account is at present being taken of the existing railway traffic between Halifax and Amherst, by the commissioner appointed by Nova Scotia to collect statistics for the railway. The same is being done for that portion of the line along the banks of the St. Lawrence.

There is some reason to believe that these two portions of the line will be found to have sufficient traffic to pay, over and above working expenses, the moderate interest upon capital of 4 per cent.

If such should prove to be correct, then the foregoing statement would be modified, and stand thus :—

		Miles.
Total distance, Halifax to Quebec		635
Quebec to Rivière du Loup	110	
Halifax to Amherst and Bay Verte	125	
		235
Leaving unproductive still		400 miles.

If the total line can be done for 3,000,000*l.*, then the proportion for the 400 miles would be 1,889,600*l.* or 2,000,000*l.* nearly.

The interest for which would amount to 80,000*l.*

Deducting 20,000*l.* for the conveyance of the mails, then the sum to be responsible for would be 60,000*l.*, which, divided proportionally as before, would give for

Nova Scotia	£12,000	Proportion	·2
New Brunswick	12,000	„	·2
Canada	18,000	„	·3
Great Britain	18,000	„	·3
Total	£60,000		1·0

Therefore, for the responsibility (perhaps for assuming it only) of 100,000*l.*, or as the case may prove, 60,000*l.*, the Quebec and Halifax Railway may be made.

But to look to this great work only as a commercial speculation, and as yielding mere interest for the expenditure incurred, would be to take a very limited view of the objects it is capable of achieving.

In the United States they are well aware of the increased value which internal improvements and communications give to property of every kind.

In those countries works have been undertaken for that object alone, not for the mere return which the work—whether railway, road, or canal—would make of itself.

The indebtedness of the several States has been incurred almost entirely in making great internal improvements; and in the boldness and unhesitating way in which they have incurred debts and responsibilities, for the purpose of developing their resources, may be seen the secret of their unrivalled prosperity.

The State is in debt, but its citizens have been enriched beyond all proportion.

Most unfavourable comparisons are made by travellers who visit the British provinces and the United States; and some have gone so far as to state, that travelling along where the boundary is a mere conventional line, they could at once tell whether they were in the States or not.

On the one side the State Governments become shareholders to a large amount in great public works, lead the way, and do not hesitate to incur debt, for making what has been termed "war upon the wilderness;" employment is given, and by the time the improvement is completed, property has been created, and the employed become proprietors.

On the other side the provincial Governments do not take the initiative in the same manner, and hence in the settlements, and in the provinces generally, may be seen this marked difference in the progress of people who are identically the same in every respect.

Until the British provinces boldly imitate the policy of the States in this regard, and make "war upon their wilderness," their progress will continue to present the same unfavourable contrast.

The creative or productive power of canals, railways, &c., may be traced in the history and progress of the State of New York.

The Erie Canal was commenced in 1817, and completed in 1825, at a cost of 7,143,789 dollars, or 1,400,000*l.* sterling. In 1817 the value of real and personal property in the city of New York was, from official documents, estimated at 16,436,000*l.* sterling. In 1825 it was estimated at 21,075,000*l.* sterling. In 1820 the population of the State was 1,372,000*l.*, and in 1830 the population of the State was 1,918,000*l.*

The canal was found so inadequate to the traffic, that between the years 1825 and 1835, a farther sum of 2,700,000*l.* was to be expended in enlarging it *.

Making the total cost to that date 4,100,000*l.* sterling.

It has been seen that in the city of New York—

In 1817 the official value of real and personal property was				16,436,000*l.*
1835	„	„	„	45,567,000*l.*

Being an increase of 2¾ times in eighteen years.

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* It is to be again enlarged.

For the State of New York—

In 1817 the official value of real and personal property was 63,368,000*l.*
1835 „ „ „ 110,120,000*l.*

Or an increase of nearly 47,000,000*l.* sterling in the value of property; attributed chiefly, if not entirely, to the formation of the canals.

In 1836 the amount conveyed to tide-water by the canal was 697,357 tons.

And on the 1st of July of that year there had accumulated in the hands of the Commissioners an amount sufficient to extinguish the whole of the outstanding debt incurred in its construction.

The net receipts from all the State canals, after deducting the expenses of collection and superintendence, for the year 1847, was 449,270*l.* Villages, towns, and cities have sprung up along its course.

The population of the State, which was—

In 1810	959,949
Was in 1845	2,604,495

In 1846 the value of real and personal property was estimated at 128,500,000*l.*

It will be seen from the above, therefore, that in addition to the wealth created for individuals, the canals produce a large annual revenue to the State.

The following extracts from the financial affairs and statistics of some of the States may be quoted in illustration of this part of the subject:—

1847.

MASSACHUSETTS.

	Dollars.
Total indebtedness of the State, 1st January, 1847	999,654
Credit of the State, lent to railroads	5,049,555
Total liabilities of the State	6,049,209

As security for the redemption of the scrip lent to railroads, the Commonwealth hold a mortgage on all the roads, and also 3000 shares in the Norwich and Worcester, and 1000 in the Andover and Haverhill.

PENNSYLVANIA.

	Dollars.
Public property, canals, and railroads, at original cost.	28,657,432

MARYLAND.

	Dollars.
Receipts from Baltimore and Ohio Railroad	42,402
Ditto from Canal Companies	11,550

NORTH CAROLINA.

	Dollars.
Debt of the State, on account of Railroad Companies	1,110,000

OHIO.

	Dollars.
Debt contracted for the sole purpose of the construction of Public Works within the State	19,246,000
Canals, 820 miles in length, cost	15,122,503
Net receipts in 1846, after paying repairs and expenses	408,916

In 1810 the population of this State was	45,865
In 1820 „ „	581,434
In 1840 „ „	1,519,467

Or tripled nearly in 20 years, during the progress of her canals.

MICHIGAN.

	Dollars.
Debt on 30th November, 1845	4,394,510

Total length of railroads finished and belonging to the State, 222 miles.

This State was authorized to raise a loan of 5,000,000 dollars for internal improvements.

For the same purpose, Congress granted to this State 500,000 acres of land.

In 1840 the population was	212,267
In 1845	304,278

Or an increase of 50 per cent. nearly, in five years.

INDIANA.

	Dollars.
In January, 1847, the public debt was	14,394,940

By the terms of the Act adjusting this debt, it is to be equally divided between the State and the Wabash and Erie Canal. Of this canal, which is to be 458 miles long, 374 miles are in Indiana; 174 of this portion are finished, and in operation. There remain 200 miles to be completed, upon which part about 1,200,000 dollars have been expended by the State. It is estimated to cost the farther sum of 2,000,000 dollars to complete the entire canal. To cover this amount, the State is to transfer to trustees 963,126 acres of land adjoining to or in the neighbourhood of the canal.

The population of this State, in 1811, was . .	24,520
„ „ 1830, was . .	343,031
„ „ 1840, was . .	685,086

Or doubled in ten years.

ILLINOIS.

		Dollars.
1847.	Total internal improvement debt	8,165,081
	Total canal debt	6,009,187
		13,174,268

The population in 1830 was	157,455
„ 1840 was	476,183

Or tripled in ten years.

The sales of the public lands during one year (1845)

	Acres.
In the United States amounted to . . .	1,843,527
	Dollars.
Producing	2,470,298

Or an average of 5*s.* 7*d.* sterling per acre.

But to show the effect produced by a canal or railway passing through property, the following extract may be quoted from the Report of a Board of Directors of the New York and Erie Railroad Company in February, 1844:—

"The Board find that they have omitted one description of property, which has heretofore been considered of great value, but the right to most of which has been lost to the Company by failure to complete the road within a certain period; the most valuable of which consisted of 50,000 acres of wild land in Cattaraquas county, near Lake Erie, and one-fourth part of the village of Dunkirk.

"An offer in writing was made in 1837 by responsible parties to take these donations, and pay further the sum of 400,000 dollars, provided certain portions of the railroad were completed within a specified time."

That is, about 8 dollars, or 33*s.* 4*d.* sterling per acre.

In Michigan 461,000 acres were granted by Congress for the endowment of a university. These lands were selected, in sections from the most valuable of the State. The price of these was at one time 20 dollars, or 4*l.* 6*s.* 8*d.* sterling per acre, but became lower afterwards; 17,142 acres, the quantity sold up to 30th November, 1845, brought 2*l.* 9*s.* per acre.

69,000 acres, devoted to schools, were sold for 1*l.* 7*s.* per acre.

Such, then, are some of the results of making "war upon the wilderness."

In New Brunswick there are, according to an official Report of the Surveyor-General, dated 15th December, 1847, 20,000,000 acres, of which about 6,000,000 are either granted or sold, and 3,000,000 may be considered as barren or under water; leaving, therefore, at the disposal of the Government, 11,000,000 of acres of forest land fit for settlement.

Of the 6,000,000 granted or sold, only 600,000 acres are estimated as being actually under cultivation.

By a statistical table published by W. Spackman, London, there are—

	Acres cultivated.	Acres uncultivated.	Acres unprofitable.	Total acres.
In England............	25,632,000	3,454,000	3,256,400	32,342,000
Wales	3,117,000	530,000	1,105,000	4,752,000
Scotland	5,265,000	5,950,000	8,523,930	19,738,000
Ireland	12,125,280	4,900,000	2,416,664	19,441,944
In New Brunswick...	600,000	16,400,000	3,000,000	20,000,000

Population of England	14,995,508
„ Wales	911,321
„ Scotland	2,628,957
„ Ireland	8,205,382
„ New Brunswick	208,000

In Ireland there appears to be, from the above table, 17,000,000 acres of ground fit for cultivation, and it has a population of 8,000,000 to support.

In New Brunswick there is an equal amount of ground to cultivate, and it has only a population of 208,000 persons.

If the land yet uncleared and fit for cultivation be added, which remains in the northern section of Nova Scotia, and again between the boundary of New Brunswick and the River St. Lawrence to the east of Quebec, then there would be a quantity nearly equal to that of England itself, supporting a population of 400,000 souls only.

It is not too much, then, to say, that between the Bay of Fundy and the St. Lawrence, in the country to be traversed by the proposed railway, there is abundant room for all the surplus population of the mother country.

Of the climate, soil, and capabilities of New Brunswick, it is impossible to speak too highly.

There is not a country in the world more beautifully wooded and watered.

An inspection of the map will show that there is scarcely a section of it without its streams, from the running brook up to the navigable river. Two-thirds of its boundary are washed by the sea; the remainder is embraced by the large rivers the St. John and Restigouche.

For beauty and richness of scenery this latter river and its branches are not surpassed by anything in Great Britain.

Its lakes are numerous and most beautiful, its surface is undulating, hill and dale, varying up to mountain and valley. It is everywhere, except a few peaks of the highest mountains, covered with a dense forest of the finest growth.

The country can everywhere be penetrated by its streams.

In some parts of the interior, for a portage of three or four miles, a canoe can float away either to the Bay Chaleurs and the Gulf of St. Lawrence, or down to St. John's in the Bay of Fundy.

Its agricultural capabilities, its climate, &c., are described in Bouchett's works, in Martin's British Colonies, and other authors. The country is by them, and most deservedly so, highly praised.

There may be mentioned, however, two drawbacks to it, and only two.

The winter is long and severe; and in summer there is the plague of flies.

The latter yield and disappear as the forest is cleared; how far the former may be modified by it experience only can show.

For any great plan of emigration or colonization, there is not another British colony which presents such a favourable field for the trial as New Brunswick.

To 17,000,000 of productive acres there are only 208,000 inhabitants.

Of these 11,000,000 are still public property.

On the surface is an abundant stock of the finest timber, which in the markets of England realize large sums annually, and afford an unlimited supply of fuel to the settlers.

If these should ever become exhausted, there are the coal-fields underneath.

The rivers, lakes, and sea-coasts abound with fish.

Along the Bay Chaleurs it is so abundant that the land smells of it; it is used as manure; and while the olfactory senses of the traveller are offended by it on the land, he sees out at sea immense shoals darkening the surface of the water.

For about the same expense, five emigrants could be landed in New Brunswick for one in the Antipodes. Being within a fortnight by steam from London, any great plan of colonization could be directed and controlled by the Home Government.

In case of distress or failure, it would be long previously foreseen; the remedy or assistance could be applied; or, if beyond these, there would be the upper country and the Far West always open, and ready to receive the colonists.

The present limited population being so generally engaged in the pursuit of the timber trade and in the fisheries, there is the richest opening for agriculturists.

New Brunswick annually pays to the United States upwards of 200,000*l.* for provisions and other articles which she can raise upon her own soil.

Nova Scotia does very nearly the same thing.

Whilst within a few miles' reach of their own capitals, there is abundance of land for agricultural productions, these two provinces are dependent for large supplies of food upon the United States.

Flour is imported from as far as New Orleans.

Wheat grown in the valley of the Mississippi is shipped at St. Louis, and imported into New Brunswick. It is ground into flour at the mills of St. John, and furnishes a large share of the bread eaten by the labourers of that city.

There exists, therefore, a good market already on the spot for agricultural produce; and it would be a strange anomaly, indeed, if a country situated within three or four weeks' sail of the markets of England could not compete with the growers of produce in the valley of the Mississippi and the countries round the great lakes in the Far West.

One thing, however, is greatly to be deprecated; that is, any sudden or large emigration without previous preparation.

Before wheat or food of any kind can be grown, the forest has to be removed; and that is a work of time and hard labour, during which those engaged in it must be fed from other sources.

With some little previous detailed surveying, the proposed railway can be commenced both at the Quebec and Halifax ends as soon as decided upon, and carried on for miles. During which time the further detailed survey necessary for the remainder of the line, and particularly the portion through the wilderness, might be made, and the line actually marked and cut throughout.

This line, when cut, would form a basis for laying out extensive blocks of land, and dividing them into allotments for settlers.

It will be unnecessary in this Report to recapitulate all the good effects produced upon every country in which railways have been established; but some may be mentioned.

They have become necessary to the age, and that country which has them not must fall behind in the onward march of improvement, and in the development of its resources; and the longer it is suffered to do so, the greater and more unfavourable will be the contrast which it will present to the world.

Already in this respect the British provinces of Nova Scotia and New Brunswick are far behind their enterprising neighbours.

One of the immediate effects of making this railway would be to place them in a position of equality. They are now dependent upon them for food.

At the closing of the navigation of the St. Lawrence, if the United States were merely to prohibit the exports of provisions from their own harbours, the consequences would be serious to these two provinces. Canada could not then supply them.

In May, 1847, when the exploratory parties were being formed at Fredericton, and provisions were being forwarded to the woods for their use, there was a scarcity of flour at St. John. It was said that sufficient for only two or three day's consumption remained in that city. The prices rose considerably, and the scarcity was only averted by the arrival of some cargoes from the United States intended for Eastport.

The railway, had it been established, would have prevented such a state of things, and may save it for the future.

For the want of such a communication, Nova Scotia now finds it easier and more advantageous, notwithstanding a heavy duty of 20 per cent. against her, to export her great staple of fish to the States than to Canada; whereas, if the railway were made, it would pass on to the latter, where there would be an extensive market for it, and flour would be received in return.

Halifax would become the grand emporium of trade for the British provinces.

With the assistance of the electric telegraph, an order from Quebec could be received in a few minutes, and the articles wanted could be sent off by the next train.

As the vessels now arrive in fleets in the spring, and again in the autumn, it is a matter of forethought and consideration to the merchant of Canada to know what he shall provide himself with.

To the intending emigrant it will afford him the choice of any month in the year to set out for his new country, and if, by means of friends previously settled, his place of abode has been chosen, he can time his arrival so as to have the shortest possible time to wait until his own crops are ready to supply him with food.

Arriving now, as thousands annually do, in the spring, when the seed time is at hand, and the land uncleared, they lose the valuable opportunity of that year's crop, and have to wait over, existing, perhaps, upon their little capital for nearly eighteen months, until the succeeding harvest comes to them. To all such emigrants nearly a year may be saved.

Surprise has sometimes been expressed that out of so many who yearly land in the provinces, so many pass on and become settlers in the States.

To the poor man his labour is his capital, and he must transfer himself to the place where employment is to be found.

The proposed railway would be such a work as would engage thousands in its immediate construction; while the stimulus and new spirit it would infuse into the whole community, now cribbed and confined as it were to their own locations, would give rise to branches and other works which would employ additional thousands.

It has been seen that the population of some of the Western States have doubled and even tripled themselves in the course of ten years.

The population of New Brunswick is now only 208,000. Her revenue in 1847 was 106,000*l.* sterling, or 10*s.* per head.

There is no apparent reason why, if the same facilities of employment and land for settlement were afforded, that her progress should not be also very great.

Every emigrant, induced to settle and remain in the country, may be calculated as producing 10*s.* annual revenue to the province.

If the formation of the railway increased the population of New Brunswick by 40,000 persons only, then her proportion of the guaranteed interest would be covered from that cause alone.

The same might occur also to Nova Scotia and Lower Canada.

It may be asked, what is to become of the labourers employed upon the railway during the winter? This is the season when lumbering or cutting of timber commences. They might engage in it also. But with the wages earned in the summer they should be incited to purchase small lots of ground of about fifty acres each.

The labours of the season over, or suspended upon the railway, they could most advantageously employ themselves in clearing, logging, and improving their own lots. This they could do to such an extent, that in the spring the women and older children could burn the logs off and put in some sort of crops for food, such as potatoes, Indian corn, &c.

Mechanics might either do the same, if railway work could not be found for them, or find employment in the towns.

Another great effect of the railway would be to enhance almost immediately the value of all real and personal property. The effects produced by the Erie Canal in doubling and nearly tripling that of the city of New York has been stated.

Villages and towns would, no doubt, spring up in its course the same as on the canal. The railway would give them birth; agriculture and external commerce would support and enrich them.

But if, by its means, the navigation of the Gulf of St. Lawrence is spared, what an amount of human suffering and loss of life will it not save.

The losses from shipwreck have been great, but not equal to that arising from protracted voyages and crowded emigrant ships.

In 1847, 89,738 persons emigrated to the British provinces, of whom 5293 persons perished at sea, and 10,000 are said to have died after their arrival.

This was a most unusual year, and it is to be hoped, by every friend of humanity, that anything like it will never occur again.

No human means could have saved all this loss of life, but there is no doubt a less protracted voyage, and a more favourable time than the spring of the year in the St. Lawrence, would have prevented some of the fatal results.

The railway established, the passage may be shortened, and the time of emigration may be selected at choice.

Troops are annually moved to and from Canada. About the close of the navigation in 1843, a transport, having the 1st Royal Regiment on board, was wrecked in the mouth of the St. Lawrence. The men got safely on shore, but there were no roads or means of getting away from the place. By the personal exertions of one of the officers, who made his way through the woods on snow-shoes to the nearest settlements, and thence to Quebec, information was given of the wreck, and a steamer sent down to take them off. But for this, the consequences must have been that the regiment would have had to winter there in the best manner they could.

Embarking and disembarking at Halifax, all danger and inconvenience from the Gulf navigation would be avoided. Time and expense would be saved, and the season might be disregarded.

The mails to and from Canada could pass over British territory exclusively, and they would be received at Quebec before the steamer reached Boston, and at Montreal about the same time as it arrived at that port.

In a political and military point of view, the proposed railway must be regarded as becoming a work of necessity.

The increasing population and wealth of the United States, and the diffusion of railways over their territory, especially in the direction of the Canadian frontier, renders it absolutely necessary to counterbalance, by some corresponding means, their otherwise preponderating power.

Their railway communications will enable them to select their own time and their own points of attack, and will impose upon the British the necessity of being prepared at all points to meet them.

It is most essential, therefore, that the mother country should be able to keep up her communications with the Canadas at all times and seasons. However powerful England may be at sea, no navy could save Canada from a land force.

Its conquest and annexation are freely spoken of in the United States, even on the floors of Congress.

Weakness invites aggression, and as the railway would be a lever of power by which Great Britain could bring her strength to bear in the contest, it is not improbable that its construction would be the means of preventing a war at some no distant period.

The expenses of one year's war would pay for a railway two or three times over.

The following extract from the Report of Lord Durham, her Majesty's High Commissioner and Governor General of British North America in 1839, is so apposite and just, and bears so strongly upon the subject under consideration, that it is conceived no better conclusion can be made to this Report than to insert it:—

"These interests are, indeed, of great magnitude; and on the course which your Majesty and your Parliament may adopt with respect to the North American colonies, will depend the future destinies, not only of the million and a half of your Majesty's subjects who at present inhabit those provinces, but of that vast population which those ample and fertile territories are fit and destined hereafter to support. No portion of the American continent possesses greater natural resources for the maintenance of large and flourishing communities. An almost boundless range of the richest soil still remains unsettled, and may be rendered available for the purposes of agriculture. The wealth of inexhaustible forests of the best timber in America, and of extensive regions of the most valuable minerals, have as yet been scarcely touched. Along the whole line of sea-coast, around each island, and in every river, are to be found the greatest and richest fisheries in the world. The best fuel and the most abundant water-power are available for the coarser manufactures, for which an easy and certain market will be found. Trade with other continents is favoured by the possession of a large number of safe and spacious harbours; long, deep, and numerous rivers, and vast inland seas, supply the means of easy intercourse, and the structure of the country generally affords the utmost facility for every species of communication by land. Unbounded materials of agricultural, commercial, and manufacturing industry are there. It depends upon the present decision of the Imperial Legislature to determine for whose benefit they are to be rendered available. The country which has founded and maintained these colonies at a vast expense of blood and treasure, may justly expect its compensation in turning their unappropriated resources to the account of its own redundant population; they are the rightful patrimony of the English people—the ample appanage which God and Nature have set aside in the New World for those whose lot has assigned them but insufficient portions in the Old."

And if for great political objects it ever become necessary or advisable to unite all the British provinces under one Legislative Government, then there will be formed on this side of the Atlantic one powerful British State, which, supported by the imperial power of the mother-country, may bid defiance to all the United States of America.

The means to the end, the first great step to its accomplishment, is the construction of the Halifax and Quebec Railway.

(Signed) WILLIAM ROBINSON.
August 31, 1848. Captain Royal Engineers, Brevet-Major.

Major-General Sir John F. Burgoyne, K.C.B.,
Inspector-General of Fortifications,
&c. &c. &c.

No. 1.

COPY of a DESPATCH from Earl GREY to Governor-General the Earl of ELGIN and KINCARDINE.*

MY LORD, Downing Street, April 5, 1849.

I have hitherto deferred answering your despatch of the 20th of December last on the subject of the proposed Halifax and Quebec Railway, because I was unwilling to abandon the hope that in doing so I might be enabled to communicate to your Lordship the determination of Her Majesty's Government to submit to Parliament some definite proposal with a view to the execution of this great national undertaking. I regret, however, to have now to inform your Lordship that, for the present at least, it has been found impracticable to overcome the difficulties which have stood in the way of every plan which has hitherto been suggested for providing for the cost of a work of such magnitude as the proposed railway. While I entirely concur in your Lordship's estimate of the extreme importance of that work to the empire at large, as well as to the North American provinces, and while I gladly acknowledge that the members of your Council have shown a disposition to do all that lies in them to promote its accomplishment, and have suggested a measure which has much to recommend it for effecting this object, still Her Majesty's Government have reluctantly come to the conclusion that in the present circumstances of this country they would not be justified in applying to Parliament for the appropriation of so large a sum for this railway as it has been estimated that it would cost. You will express to the members of your Council my strong sense of the judgment and ability they have displayed in the consideration of this important subject, although the measure they have suggested has unfortunately been found open to objections which have proved insurmountable. It would be to me a subject of deep regret if I believed that the determination not to adopt this particular measure implied that all hope of hereafter carrying the projected railway into effect by other means must be given up, but I see no reason for coming to any such conclusion, nor will I despair that this great design may at no distant period be resumed with a happier result.

I am, &c.,

(Signed) GREY.

The Right Hon. the Earl of Elgin and Kincardine,
&c. &c. &c.

No. 2.

COPY of a LETTER from B. HAWES, Esq., to J. HOWE, Esq.

SIR, Downing Street, March 10, 1851.

I am directed by Earl Grey to inform you that he is at length enabled to communicate to you the decision of Her Majesty's Government on the application for assistance towards the construction of the projected railway through Nova Scotia, contained in your letters of the 25th of November and 16th of January last.

You are already aware, from the repeated conversations which you have had with Lord Grey, of the strong sense entertained by his Lordship and his colleagues, of the extreme importance, not only to the colonies directly interested, but to the empire at large, of providing for the construction of a railway by which a line of communication may be established on the British territory between the provinces of Nova Scotia, New Brunswick, and Canada, and that various plans which have been suggested for the accomplishment of this object have undergone the most attentive consideration.

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* A similar despatch was addressed to the Lieutenant Governor of New Brunswick. No. 118. April 5, 1849.

It appears from Sir John Harvey's despatch of August 29, 1850, as well as from your letters and the verbal communications you have made to Lord Grey, that the Provincial Government of Nova Scotia, fully relying on the concurrence of the Legislature, is desirous of undertaking the construction of that part of the projected line which would pass through that province, and proposes to obtain for that purpose a loan of 800,000*l.*, which is the estimated expense of the work. The assistance which Lord Grey understands you to apply for on behalf of the province is, that the payment of the interest of a loan to this amount should be guaranteed by the Imperial Parliament, the effect of which would be that the money might be raised on terms much more favourable than would be otherwise required by the lenders.

I am directed to inform you that Her Majesty's Goverment are prepared to recommend to Parliament that this guarantee should be granted, or that the money required should be advanced from the British Treasury, on the conditions which I now proceed to state.

In the first place, as Her Majesty's Government are of opinion that they would not be justified in asking Parliament to allow the credit of this country to be pledged for any object not of great importance to the British Empire as a whole (and they do not consider that the projected railway would answer this description, unless it should establish a line of communication between the three British provinces), it must be distinctly understood that the work is not to be commenced, nor is any part of the loan, for the interest on which the British Treasury is to be responsible, to be raised, until arrangements are made with the provinces of Canada and New Brunswick, by which the construction of a line of railway passing wholly through British territory from Halifax to Quebec or Montreal, shall be provided for to the satisfaction of Her Majesty's Government.

In order that such arrangements may be made, Her Majesty's Government will undertake to recommend to Parliament that the like assistance shall be rendered to these provinces as to Nova Scotia, in obtaining loans for the construction of their respective portions of the work. If it should appear that by leaving it to each province to make that part of the line passing through its own territory, the proportion of the whole cost of the work which would fall upon any one province would exceed its proportion of the advantage to be gained by it, then the question is to remain open for future consideration, whether some contribution should not be made by the other provinces towards that part of the line; but it is to be clearly understood that the whole cost of the line is to be provided for by loans raised by the provinces in such proportions as may be agreed upon, with the guarantee of the Imperial Parliament.

The manner in which the profits to be derived from the railway when completed are to be divided between the provinces, will also remain for future consideration.

You will observe, that I have stated that the line is to pass entirely through

British territory; but Her Majesty's Government do not require that the line shall necessarily be that recommended by Major Robinson and Captain Henderson.

If the opinion which is entertained by many persons well qualified to form a judgment is correct, that a shorter and better line may be found through New Brunswick, it will of course be preferred, and there will be sufficient time for determining this question while the earlier part of the line is in progress. It is also to be understood that Her Majesty's Government will by no means object to its forming part of the plan which may be determined upon, that it should include a provision for establishing a communication between the projected railway and the railways of the United States. Any deviation from the line recommended by Major Robinson and Captain Henderson must, however, be subject to the approval of Her Majesty's Government.

It will further be required that the several Provincial Legislatures should pass laws making the loans which they are to raise a first charge upon the Provincial Revenue, after any existing debts and payments on account of the Civil List settled on Her Majesty by laws now in force; and also that permanent taxes shall be imposed (or taxes to continue in force till the debt shall be extinguished) sufficient to provide for the payment of the interests and sinking fund of the loans proposed to be raised after discharging the above prior claims. It will further be necessary that the expenditure of the money raised under the guarantee of the Imperial Parliament shall take place under the superintendence of Commissoners appointed by Her Majesty's Government, and armed with sufficient power to secure the due application of the funds so raised to their intended object. The Commissioners so appointed are not, however, to interfere with the arrangements of the Provincial Governments, except for the above purpose.

The right of sending troops, stores, and mails, along the line, at reasonable rates, must likewise be secured.

If, on the part of the Government of Nova Scotia, you should express your concurrence in the above proposal, Lord Grey will immediately direct the Governor-General of the British North American provinces to communicate with the Lieutenant-Governors of New Brunswick and Nova Scotia, who will also be directed to bring the subject under the consideration of their respective Executive Councils, in order that if they should be prepared to join in carrying the undertaking into effect on the terms proposed, the details of the arrangement between the provinces may be settled, and the sanction of the Legislatures obtained for the plan, so that it may, with as little delay as possible, be submitted for the approval of Parliament.

Before, however, the proposed measure can be so submitted to Parliament, it is proper to observe that there are some other questions affecting the pecuniary relations between the mother country and the colonies which will require to be considered; but as these questions have little, if any, reference to Nova Scotia, it is not necessary that they should be further adverted to in this letter.

I am directed to add, that Lord Grey thinks it unnecessary that any measures should be taken by Her Majesty's Government to encourage the establishment of steam-vessels for the accommodation of emigrants of the humbler class, which is one of the subjects to which you have called his attention.

If there should be a demand for such vessels, Lord Grey has no doubt that they will speedily be supplied by private enterprise; indeed, he has been informed that ships of large size intended for the conveyance of emigrants, and furnished with auxiliary steam-power, are already building both in this country and in America; and if by undertaking the projected railway a demand for labour is created in the British provinces, and a large extent of fertile land is opened for the occupation of settlers, these circumstances cannot fail to lead to an extension and improvement of the means now afforded for the conveyance of emigrants to these provinces.

Lastly, with reference to the suggestion contained in your letter, that convicts might be employed in the construction of the railway, I am to inform you that, though Her Majesty's Government entertain no doubt that the expense of the work to the provinces might thus be greatly reduced, while at the same time, by judicious regulations, all risk of serious inconvenience might be guarded against, they would not be disposed to take any steps with a view to the adoption of this suggestion, unless on a distinct application from the Colonial Legislatures; but if such an application should be made, Her Majesty's Government would be prepared to make the necessary arrangements for the employment of a moderate number of convicts on the work, without any charge for their custody and subsistence to the province which may have applied for them.

I am, &c.

Joseph Howe, Esq. (Signed) B. HAWES.

No. 3.

Copy of a Despatch from Earl Grey to Governor-General the Earl of Elgin and Kincardine.

My Lord, Downing Street, March 14, 1851.

From the correspondence which I have already had with your Lordship on the subject of the projected railway from Halifax to Quebec, you are well aware that, although Her Majesty's Government have not hitherto been enabled to take any steps towards the execution of that work, it is an undertaking which they have long earnestly desired to see accomplished, as they believe it to be one calculated very greatly to advance the commercial and political interests both of the British provinces in North America and of the mother country. It is therefore with great satisfaction that I have now to acquaint your Lordship that I have reason to hope that the time is at length come when this great national enterprise may be undertaken with advantage, if there still exists (as I am sure there does) as strong a desire to promote it on the part of the inhabitants of Canada and New Brunswick as they formerly expressed, and as the people of Nova Scotia have again recently manifested.

2. I enclose for your Lordship's information a copy of a despatch addressed to me in the course of the last autumn by Sir John Harvey, introducing to me Mr. Howe, a member of the Government of Nova Scotia, and also copies of two letters I have received from that gentleman, and of the answer which has, by my direction, been returned to him. Your Lordship will perceive from these papers, that the proposal made by Mr. Howe, on behalf of the province of Nova Scotia, and to which Her Majesty's Government have thought it their duty so far to accede as to undertake on certain conditions to recommend it for the sanction of Parliament, is to the effect that the credit of this country should be employed to enable the provinces of Canada, New Brunswick, and Nova Scotia, to raise, upon advantageous terms, the funds necessary for the construction of the proposed

railway, just as Canada has already been enabled, by similar assistance, to construct the canals by which she has lately completed the most extensive and perfect system of inland navigation which exists in the world. Although Her Majesty's Government are of opinion that great caution ought to be observed in pledging the credit of the British Treasury in aid of loans raised by the colonies, they regard the work now in contemplation as being (like the Saint Lawrence Canals) of so much importance to the whole empire, as to justify them in recommending to Parliament that some assistance should be given towards its construction; nor is there any mode of affording such assistance which has been hitherto suggested, which appears on the whole so little burthensome to the mother-country, and at the same time of so much real service to the colonies, as that which is now proposed.

3. In coming to the decision that Parliament should be invited to give this support to the projected railway, Her Majesty's Government have not failed to bear in mind that, by enabling the North American provinces to open this great line of communication, it may fairly be assumed that a powerful stimulus will be given to their advance in wealth and population, and that the consequent increase in their resources will render it possible for them to relieve the mother-country sooner, and more completely, than would otherwise be practicable, from charges now borne by it on account of these colonies. In another despatch of this date, I have informed your Lordship, that in the judgment of Her Majesty's Government, the British colonies ought to be required, as they become capable of doing so, to take upon themselves not only the expenses of their Civil Government, but a portion, at all events, of those incurred for their protection; and I have pointed out to you, that the British North American provinces, and especially Canada, have now reached such a stage in their progress, that the charges for which Parliament is called upon to provide on their account, ought to be rapidly diminished. The construction of the proposed railway would greatly contribute to promote this important object. By opening new districts for settlement, and by the demand for labour which will be created during the progress of the work, the projected railway cannot fail to increase the wealth and population of these provinces, while, by affording a rapid and easy communication between them, it will enable them to afford to each other far greater mutual support and assistance that they now can, in any difficulty or danger to which they may be exposed.

4. Your Lordship will not fail to observe from the letter which has been addressed to Mr. Howe, that the assistance which it is proposed to grant to the provinces towards the construction of the proposed railway, is to be contingent on provision being made for opening a complete line of communication from Halifax to Quebec or Montreal; it is necessary, therefore, to ascertain whether Canada and New Brunswick are ready to join with Nova Scotia in raising the capital required for the work in the manner proposed, and, if so, in what proportion each province is to become responsible for the expense incurred. The question whether it will be advisable for these two provinces to join in the construction of the projected railway, if they should be enabled, by the assistance of Parliament, to raise the required capital at a low rate of interest, is one for the consideration of their respective Legislatures; but so far as I have the means of forming a judgment upon the subject, I should anticipate that their decision would be in favour of doing so. I infer that this is probable, not less from what I have learnt of the actual state of public opinion on this subject in the provinces,

than from the view which I take of their interest in the work. Though I can well believe that there would be much room for doubting whether the railway would pay as a mercantile speculation to a company looking to traffic only for its remuneration, the case is very different when it is regarded as a public undertaking. When viewed in this light, the various indirect advantages which cannot fail to arise to the provinces from possessing such improved means of communication, must be considered, as well as the very great additional value which would be conferred on a vast extent of public lands which are now comparatively worthless. This is a source of profit from which no advantage can in general accrue to the constructors of railways in countries where the soil has long been appropriated by individuals; on the contrary, in these countries the purchase of land is not one of the least important items of the expense to be incurred in such undertakings; but where, as in parts of Canada and New Brunswick, a great part of the territory to be traversed by a railway is still unappropriated, and the land may be sold by the public, the increased value given to it by being thus rendered accessible, may render it advantageous to construct a railway, though the traffic is not expected to do more at first than pay the working expenses.

5. If these considerations should induce the Legislatures of the three provinces to combine in undertaking the projected railway, the terms on which they are to co-operate with each other for that object will have to be settled; and in coming to such an arrangement various questions of great difficulty and importance will require to be considered. For instance, it is probable that when the line is completed, the traffic will be far more remunerative at the two extremities than in the more central portion of it; while at the same time the expense of construction would, from the nature of the country, be precisely higher where the traffic returns would be the lowest; so that if each province were required to pay for the formation of the line through its own territory, and to receive the returns from the traffic through the same, it would follow, that while the expense to New Brunswick would be the greatest, its receipts would be the smallest. On the other hand, as I have just observed, one of the most important sources of profit from the construction of such a railway as that now in contemplation, would arise from the sale of land of which the value would be increased by the work; and it appears from the papers before me, that New Brunswick would probably derive a greater profit from that source than the two sister provinces. Whether the result upon the whole would be, that each province, considering, these various circumstances, ought to take upon itself the construction of the railway through its own territory, or whether, on the contrary, any one should be assisted by the others, is a point on which I have not the means of forming a judgment; and I would suggest to you, that the best course, with a view of arriving at some practical result, would be, that a deputation from the Executive Councils of the two lower provinces should proceed to the seat of Government in Canada, in order to confer with your Lordship and with your Council for the purpose of coming to some agreement upon the subject, which, after being approved by the Legislatures of the several provinces, might be submitted for the sanction of Parliament.

6. It does not appear to me that if such a conference should be held, it need occupy any very great length of time, or that much difficulty would arise in coming to an arrangement for the construction and working of the projected railway, by which the expense of the undertaking on the one hand, and the advantages to be derived from it on the other, might be fairly apportioned

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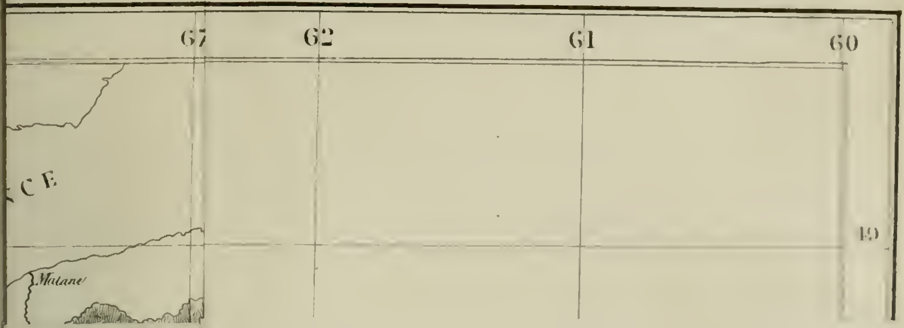
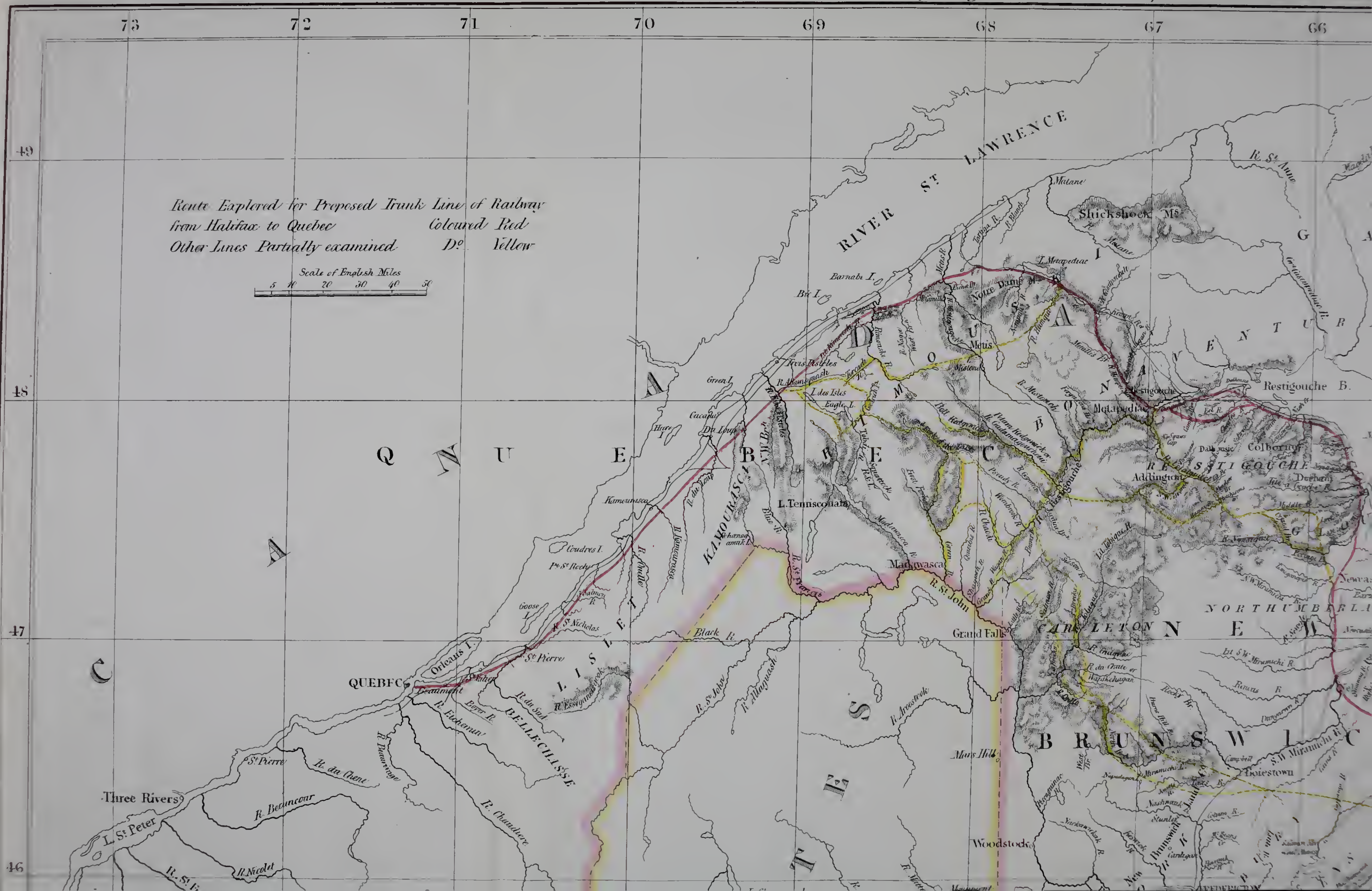
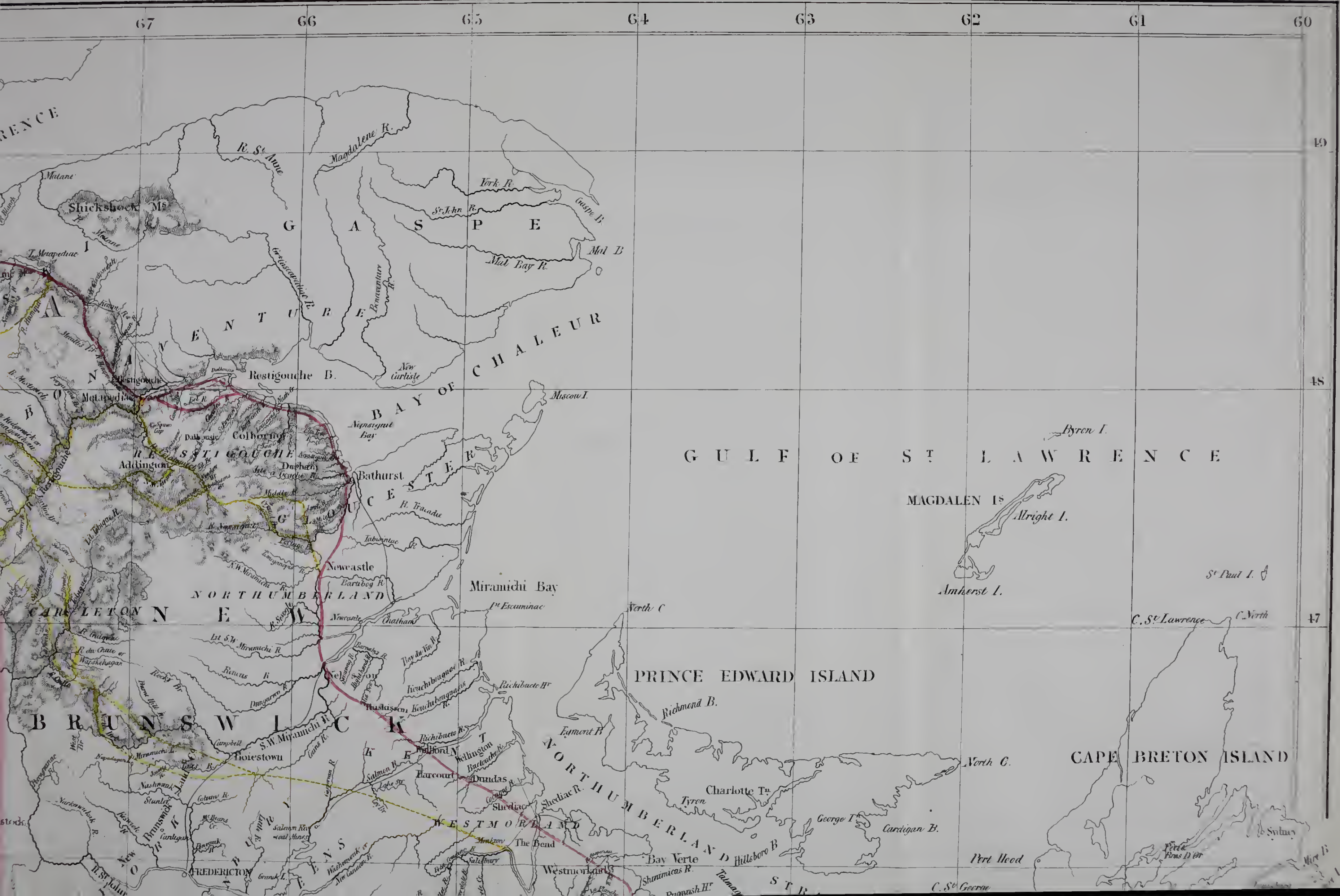
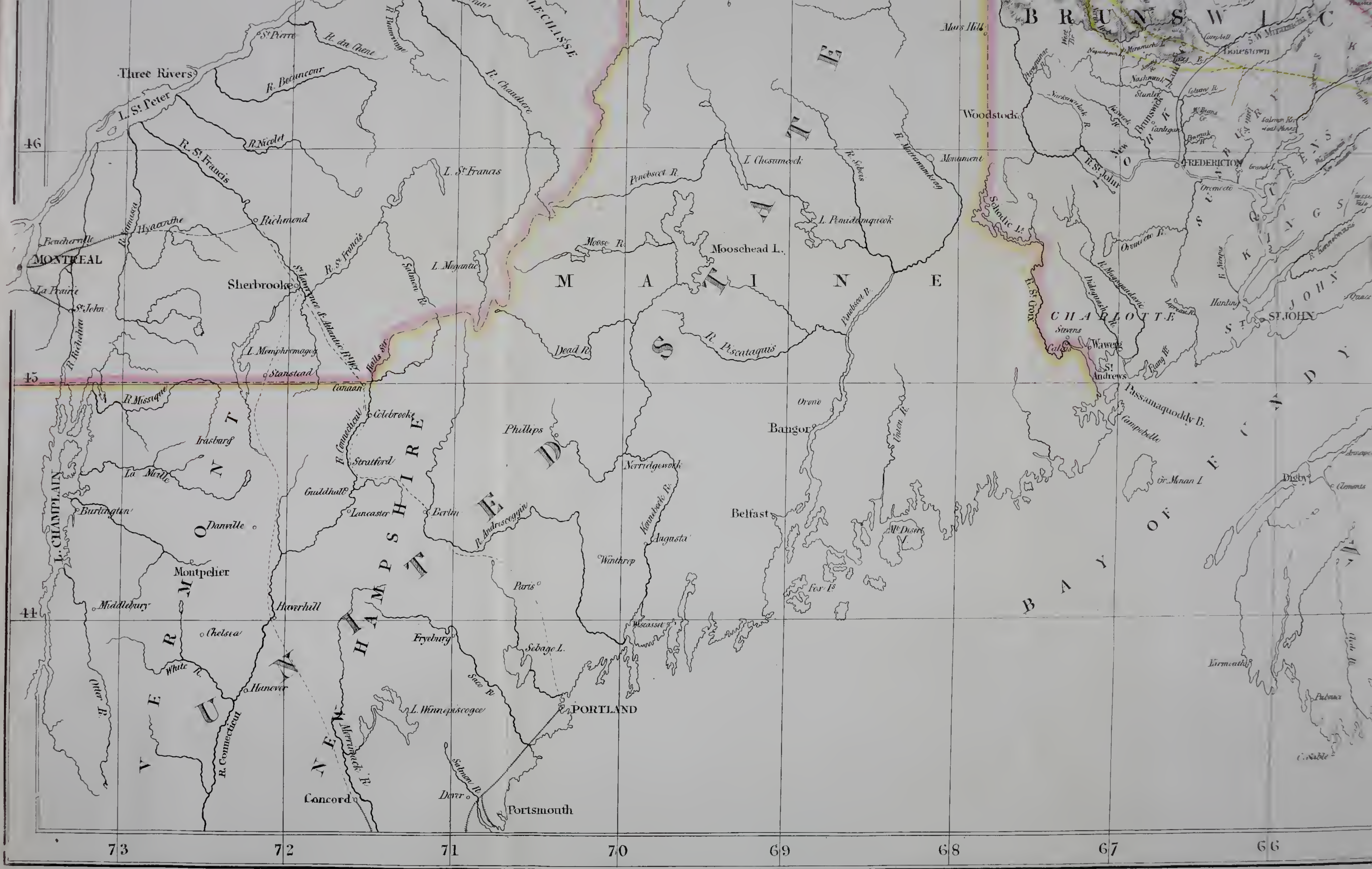


To accompany Major Robinson's Report on the Halifax



Robinson's Report on the Halifax and Quebec Railway.

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Hyacinthe
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La Prairie
St. John
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Sherbrooke
R. St. Francis
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St. Lawrence & Atlantic R.Way
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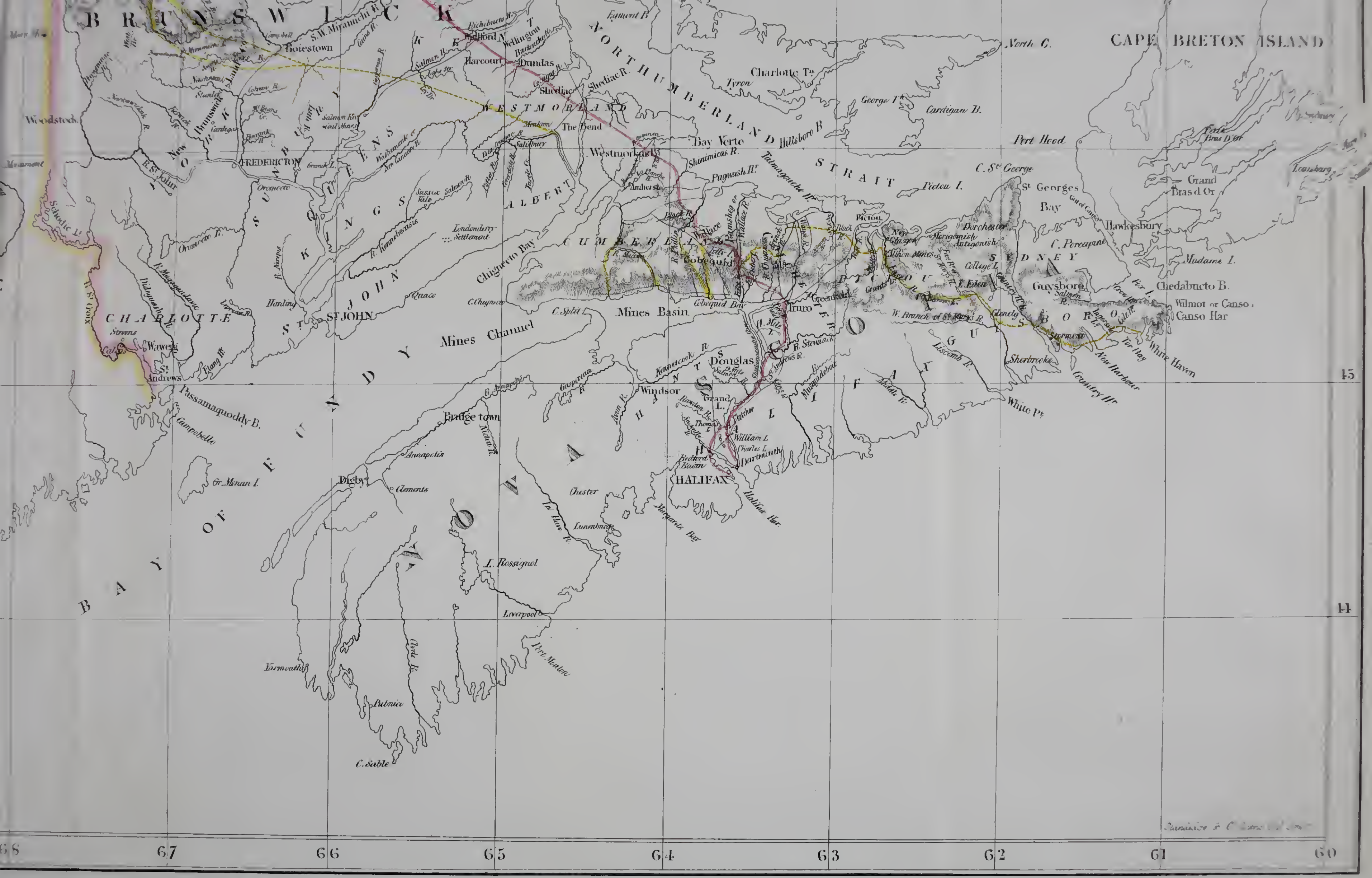
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New Brunswick
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Sussex Vale
Londonderry Settlement
Chignecto Bay
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George Tn.
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Cardigan B.
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Port Hood
C. St. George
St. Georges Bay
Hawkesbury
Grand Bras d'Or
C. Porcupine
Madame I.
Chedabucto B.
Wilmot or Canso
Canso Har
Antigonish
Dorchester
Merigomish
New Glasgow
Albion Mines
Guysboro
Sherbrooke
Liscomb R.
White Pt.
New Harbour
Country Hr.
Tor Bay
White Haven
Douglas
Windsor
Grand L.
Dartmouth
Bedford Basin
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Halifax Har.
Margarets Bay
Chester
Lunenburg
La Have R.
Bridge town
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between the different provinces. Hereafter I may probably be enabled to offer some suggestions as to the manner in which this might be accomplished; but at present I have only to add, that I shall transmit copies of this despatch to Sir Edmund Head and to Sir John Harvey, with instructions to them to communicate with your Lordship without delay on the important subject to which it relates; and it will give me the highest satisfaction if the result of these communications should be the undertaking of a work, which, if completed, cannot, I believe, fail to add greatly to the prosperity of the British provinces in North America, and at the same time to give additional strength to the ties which connect them with each other and with the British Empire.

I am, &c.,

(Signed) GREY.

The Right Hon. the Earl of Elgin and Kincardine,
&c. &c. &c.

PAPER IV.

Gunpowder Buildings. By Captain Yorke, R.E.

Buildings in which the several processes of manufacturing gunpowder are carried on, were generally constructed entirely of wood, on the principle that in the event of an explosion taking place, but little resistance was offered by the walls and roof, and thus the damage done to the building would be but slight. This may hold good as regards the first process, that of the incorporating of the three ingredients, where the composition has not attained to the explosive power which it afterwards obtains by the higher processes of pressing and granulating. The quantities also in each incorporating mill are comparatively small, consisting only of two charges of 42 lbs. each. In the higher processes, not only are the quantities considerable and the explosive powers great, but an impalpable powder or dust is created, which, penetrating through every crevice, covers the inside and outside of the walls and roof, and settles upon the leaves and branches of the surrounding trees, and, falling upon the ground, forms in dry weather a train surrounding the building to some distance. In the event, therefore, of an explosion taking place in a building (suppose in one where the mill cake is broken), the force of the explosion of the gunpowder under process, assisted by that of the accumulations of dust in all parts of the building, would be sufficient to blow lighted particles of the building to a considerable distance, which, alighting upon or near to a similar building, would fire the dust before alluded to, and cause a second explosion, and so on. The great explosion at the Government manufactory here in 1843 was much increased in this way; and that at Hounslow, in March, 1850, gave a still clearer proof of the wrong construction of the several buildings there. An explosion in one building caused the consecutive explosions of five others placed at distances of from 70 to 190 yards apart, and within the apparent shelter of a fine plantation of firs. Messrs. Curtis, the owners of these mills, then turned their attention to the consideration of what were the best materials with which to construct their buildings. Among other trials, the best appeared to be that of making the roof entirely of copper, the framing made hollow of sheet copper, and the roofing of sheets soldered together and tied down to horizontal wires 1 foot apart, kept in their places by small hooks on the principals; the walls of the building were, however, of the usual weather boarding. In consequence of the great expansion and contraction of the copper, the solder (I have been lately informed by one of these gentlemen) soon fell out, and, the roof becoming leaky, the whole was removed; some better mode of joining the sheets together by lapping over the edges might, however, have been tried.

This copper roof has been replaced by a flat wooden one, supporting a tank for water. Although lighted particles falling upon this roof would be thus extinguished, yet as the dust can escape through the weather boarding of the sides, it is not altogether secure from explosion by contact.

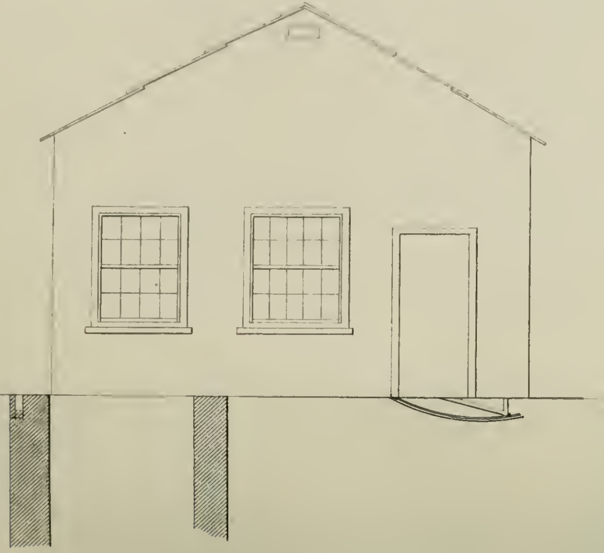
As by the Annual Estimate for 1850–1, the Engineer Department received authority to erect a building at this station for the reception of a new breaking down machine, a good opportunity was offered for taking into consideration what were the best materials with which to construct a building of this nature. The following was the mode proposed by me, and eventually approved of. The walls to be of brick, lined with ½-inch slabs of Bangor slate. The framing of the roof to be as light as possible, and of the American hemlock pine, which possesses the property of not burning with readiness, requiring a strong fire to consume it. The roofing to be of ½-inch Bangor slates 4 feet 3 inches, by 3 feet 6 inches, screwed down to the principals with 1¼-inch copper screws, the joints to be covered with a slip of the same slate 3 inches wide, also screwed down to the rafters. The lining of slate prevents any grit from the brick walls falling upon the floor; and the slabs being large and the joints few, and these rubbed and well puttied, no dust can escape, as it does in a wooden building, and no accumulations of it take place within the building. This lining has been painted two coats of stone colour, giving it a light and smooth appearance, and should any fracture take place, it will be readily detected by the difference of colour.

The accompanying plan and sections will show this building as completed for the reception of the water-wheel and machinery constructed for it at the Inspector of Artillery's Department, Woolwich. The distances between the principals must depend upon the exact breadth of the roofing slates, and is 3 feet 6 inches on the average. The tension bolts, of ¾-inch copper, pass through the wall plates, and are four in number. The suspension bolts are of the same material and size. All the floor hinges, nails, and screws used in the entire building are of copper; the door is covered with tanned leather nailed to the floor with 1¼-inch copper boat nails, to prevent the gunpowder dust falling through the flooring boards, and gradually accumulating. To prevent condensation on the roof within the building, openings are made in the front and rear doors, and one of Arnott's ventilators fixed in the gable next the tail stream.

The water-wheel house consists of a roof of galvanized corrugated iron supported on a framing of hemlock.

It is, perhaps, to be regretted that galvanized iron has not been fairly tried for gunpowder buildings, as it appears to possess so many of the qualities required; but it has been thought that the saltpetre lodging upon the surface of the inner portion of a roof constructed of this material would corrode it, and in time cause particles of the iron to fall into the composition under process; this might, however, be obviated be periodically painting the internal portion of

Elevation of End next Tail Stream



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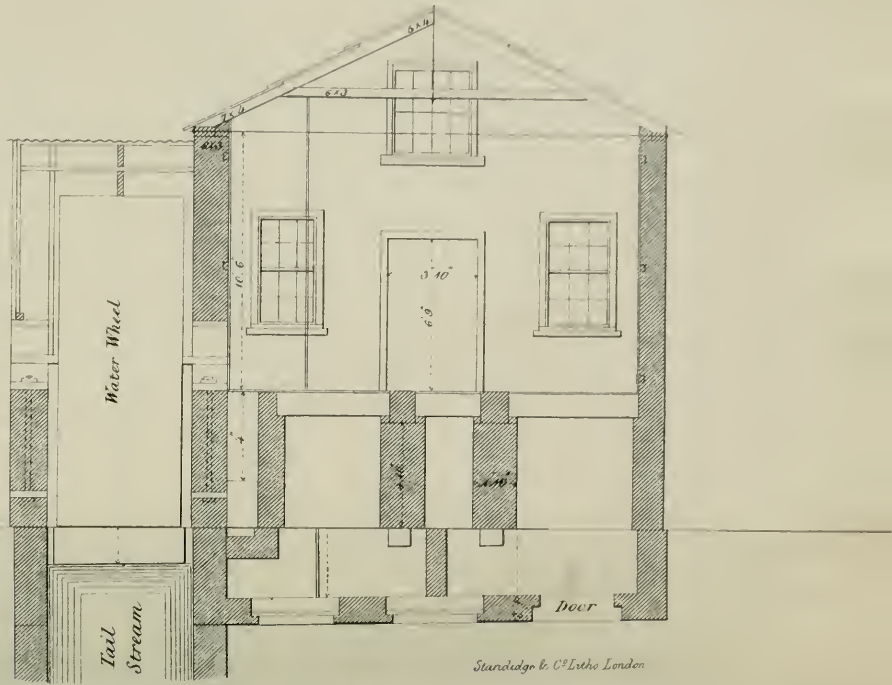

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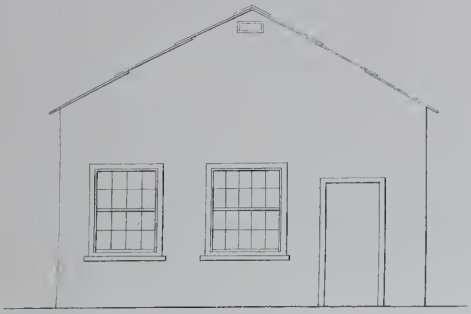
Elevation of End next Tail Stream



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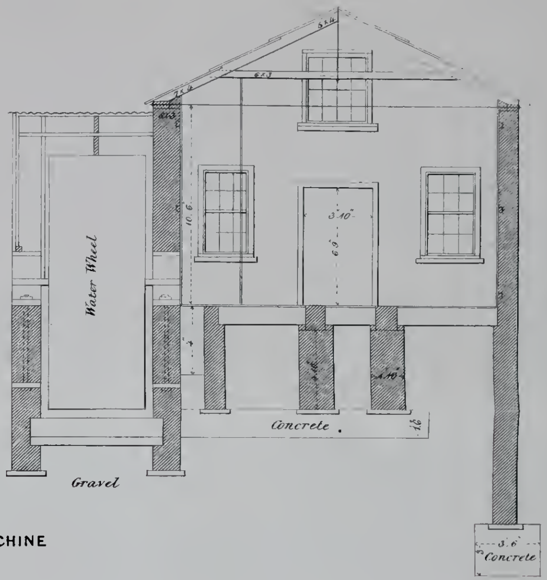
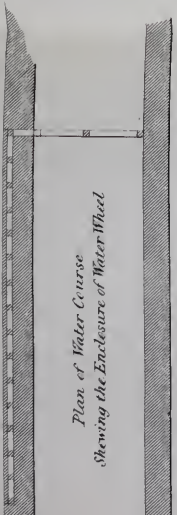
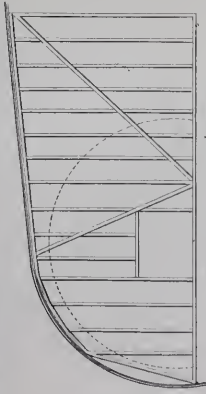


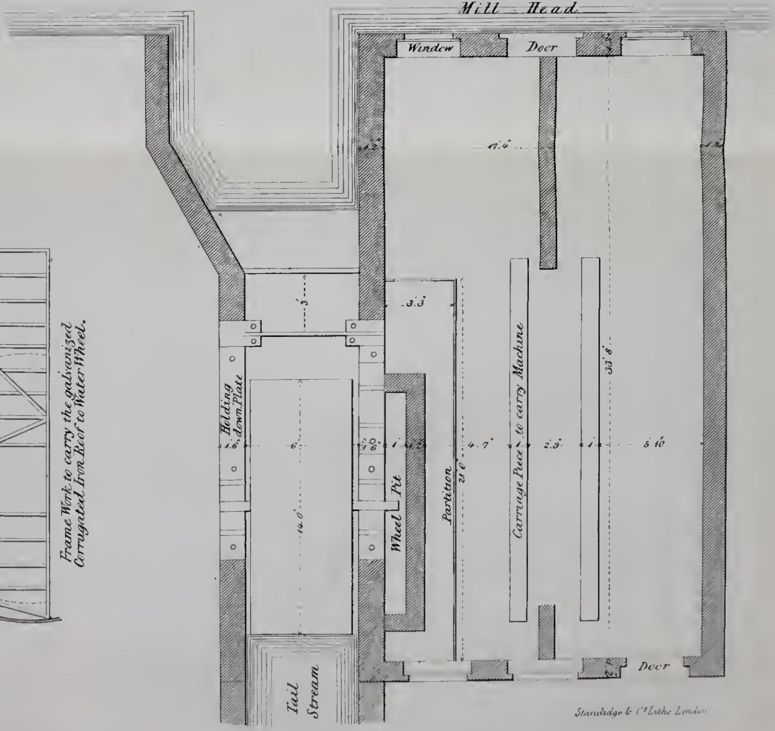
PLAN &c OF A BUILDING TO RECEIVE THE BREAKING-DOWN MACHINE
ROYAL GUNPOWDER MANUFACTORY,
WALTHAM ABBEY.
1851.



Plan of Water Course
Shewing the Enclosure of Water Wheel



Frame Work to carry the galvanized Corrugated Iron Roof to Water Wheel.



Standidge & Co Litho London

Scale 8 feet to an Inch

the roof. A more serious objection has also been offered—of its danger from lightning; Professor Faraday having given it as his opinion that in a roof of this material the chances of danger from lightning were one in 10,000, an opinion which might almost be considered as in its favour, particularly as it is well known that a flat surface of iron does not attract lightning. It is, however, perhaps more advisable where gunpowder is concerned, to be on the safe side.

F. A. YORKE, Capt. R.E.

Waltham Abbey, 30th May, 1851.

PAPER V.

Demolition of the Forts on the Canton River. By Lieut.-Colonel Phillpotts, R.E.

(Copy.)

Victoria, Hong Kong, 15th April, 1847.

Sir,

I have the honour to report to you, for the information of the Honourable the Major-General Commanding, that in obedience to his directions, conveyed by your letter of the 4th instant, I proceeded on the morning of the 5th, at seven o'clock a.m., accompanied by Major Aldrich, and the other officers of Engineers, together with the detachment of Royal Sappers and Miners, and a supporting party consisting of the Grenadier Company of the 18th Royal Irish Regiment, under Captain Campbell, in the boats of H.M.S. *Vulture*, for the purpose of destroying the stone tower, or keep, within the fort, called the French Folly, as well as any defensive arrangements that might be found in the Dutch Folly and Rouge Forts, which had been reported to the Major-General on the previous day to have been re-armed and preparing for action.

The French Folly Fort, which is situated about two miles below the city, on the north side of the river, opposite to the Western, or upper end of Napier's Island, though much smaller than either of the Anunghoy Forts, is far more formidable; inasmuch as besides standing on a small island, that renders it very difficult of access on all sides except by boats, it had a stone tower, or keep, 54 feet by 42 feet, and 24 feet high, built of very large ashlar; on which 12 guns were mounted, that completely commanded the parapet of the battery, and thus afforded a heavy plunging fire over it.

The walls of this battery are 8 feet thick and 14 high, above the level of the river. There are 24 heavy guns mounted on it, a fleur-d'eau from 8 to 12 inches in diameter, which, if properly served, would effectually prevent any vessels from passing up or down the river,

Over these guns is a banquette, with loopholes for musketry, the whole forming a very strong defence against any attempt that might be made to take it by assault.

When this fort was taken under the Major-General's immediate supervision, on the 3rd instant, by the party under Major Aldrich, R.E., the guns were all spiked; but as the garrison threw water on the powder in the magazine before they evacuated it, we had not then the means of blowing it up.

On approaching the fort on the 5th instant, Major Aldrich landed with the supporting party, and having ascertained that it was in the same state as when we left it on the 3rd instant, I directed him to cause the party to extend round the neighbourhood, in order to keep the mob from molesting us, and likewise to drive away the inoffensive inhabitants to such a distance as would prevent them being injured by the explosion.

Acting on the principle laid down by the Major-General for our guidance on this expedition, not to do anything that would in any manner injure the defenceless inhabitants, nor, indeed, to do any other injury to the forts, &c., on the river, than merely to render them useless for the time being, I considered it desirable only to employ such a quantity of powder as would merely throw down the keep, without destroying the outer walls of the fort, and thus save the people who reside all around it from suffering any ill consequences from the explosion.

I accordingly directed the charge of powder to be limited to 300 lbs., and while the Sappers, under Lieut. Da Costa, R.E., were placing the powder in the magazine, and preparing it for explosion, I directed Capt. Durnford, R.E., to make as correct a sketch as possible of the fort, &c., in order that he might be able, at his leisure, to prepare a plan of the work for the Major-General, showing the effect produced.

While these preparations were going on, Lieuts. Pasco, Coote, and Durham, R.N., with the pinnace and paddle-box boats of H.M.S. *Vulture*, the former carrying a 12-pounder carronade, and the two latter a 24-pounder carronade each, with a detachment of the Royal Marine Artillery under Lieut. Davis, were employed in driving away the numerous boats and junks that were anchored close under the walls of the fort.

These arrangements being all made, the supporting party withdrew, and re-embarked. I left Capt. Durnford, R.E., to complete the train, and fire the charge, on a signal being given, as soon as the boats with the troops had pulled off to a sufficient distance to be out of danger.

Capt. Durnford performed this duty in a most satisfactory manner. A short time after the signal was given for the explosion, he was seen pulling out to the rest of the party in the gig of the pilot, and in five minutes afterwards, being the time agreed upon, a low rumbling sound was heard, a large dense mass of black smoke was seen to rise from the fort, and when it had subsided, the keep, with the exception of a portion of the west end of the wall, was no longer visible.

On returning to the fort, in order to see the effect produced by this explosion, I found the keep entirely destroyed, not a vestige of it remained standing except the wall of the west end; which, however, was so much shaken as to render it highly dangerous to pass near it. The large hewn stones which had been used in building it (many of them 8 feet in length) were overhanging the foundation, ready to fall at any moment. At the same time the walls of the surrounding battery remained uninjured, with the exception of two cracks that had been made on the south side, about 30 feet apart, between which two of the heavy guns had forced open the doors, by which the embrasures were closed, and their muzzles appeared outside.

I have, &c., &c.,

(Signed) GEORGE PHILLPOTTS,
Lieut.-Col. and Com. R.E.

Captain Bruce,
Assistant Adjutant-General.

P.S. I inclose the Plan made by Capt. Durnford, showing the state of the fort before and after the explosion. G. P.

Pl. 1

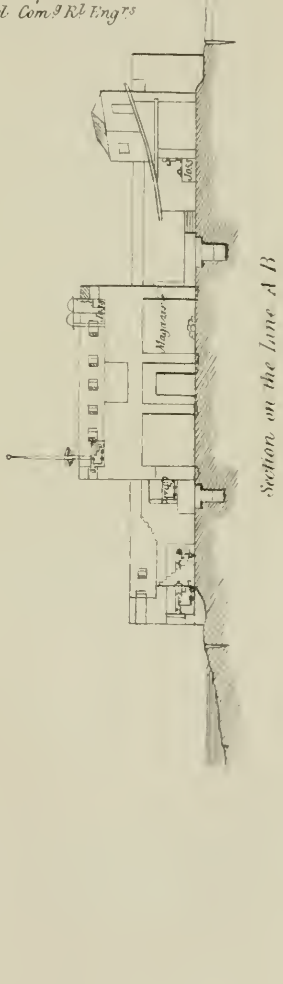
Nº 1.

ELEVATION and SECTION of the FRENCH-FOLLY-FORT, in the Canton River,

before the blowing up of the KEEP,
5th April, 1847.

Scale 40 Feet to an Inch
10 20 30 40 50 60 70 80 90 Feet

m a Reconnoissance made at the time by
Captain E. W. Durnford R.E.
accompany Lieut. Colonel Phillpotts' Letter to
yor General D'Aguilar, of the 15th April, 1847
Signed)
George Phillpotts
Lt Col. Comg Rl Engrs



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No 1.

PLAN, ELEVATION and SECTION of the FRENCH-FOLLY-FORT,

in the Canton River,

before the blowing up of the KEEP,

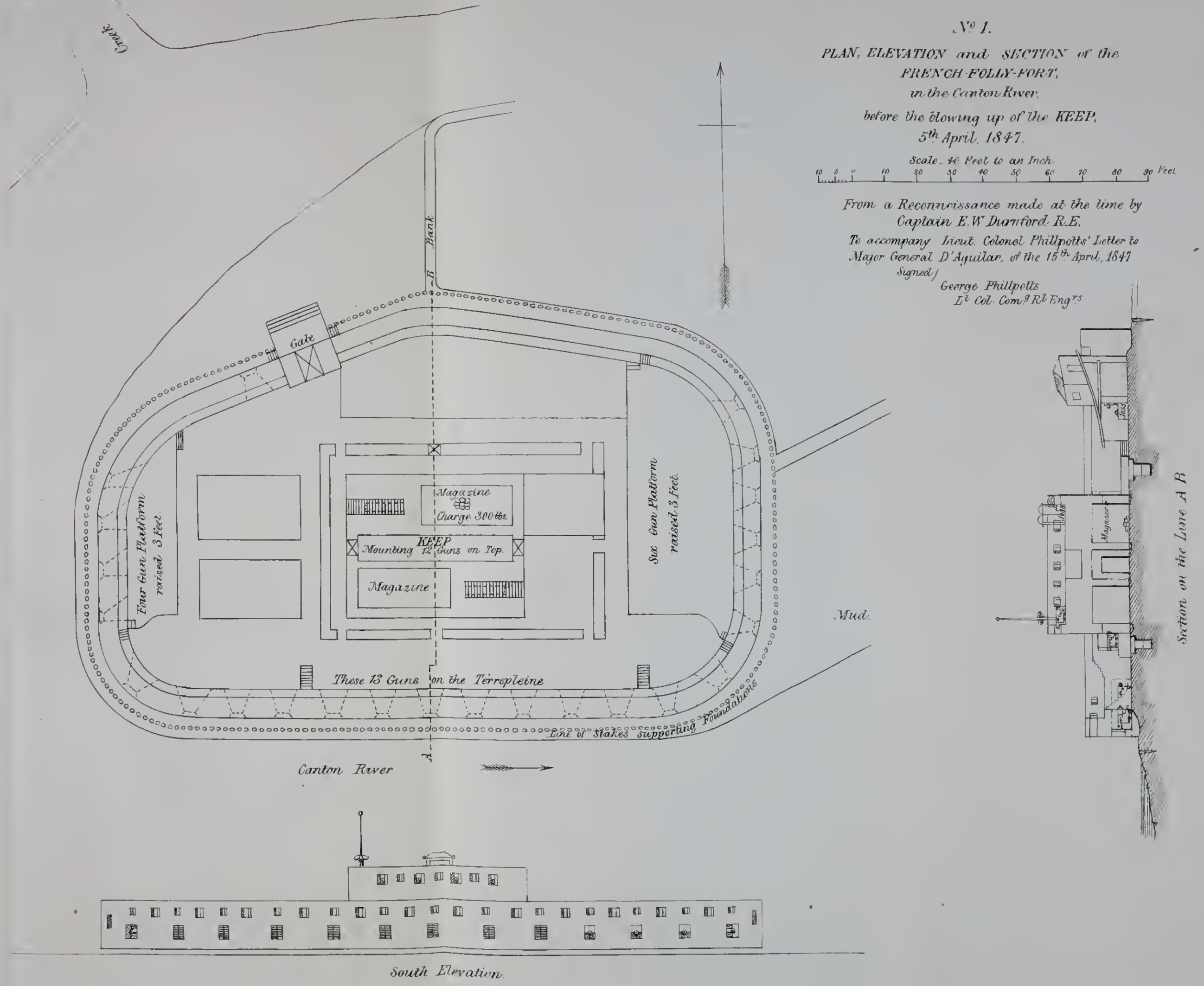
5th April, 1847.

Scale - 40 Feet to an Inch.

From a Reconnoissance made at the time by
Captain E.W. Durnford R.E.

To accompany Lieut. Colonel Phillpotts' Letter to
Major General D'Aguilar, of the 15th April, 1847

Signed/
George Phillpotts
Lt Col. Comg Rl Engrs


10 5 0 10 20 30 40 50 60 70 80 90 Feet
Creek
Bank
B
Gate
Four Gun Platform raised 3 Feet.
Magazine
Charge 300 lbs.
KEEP
Mounting 12 Guns on Top.
Magazine
Six Gun Platform raised 3 Feet.
Mud.
These 13 Guns on the Terrepleine
Line of Stakes supporting Foundations
A
Canton River
South Elevation.
Joss
Magazine
Section on the Line A B

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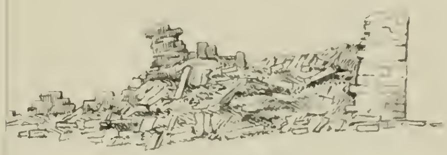
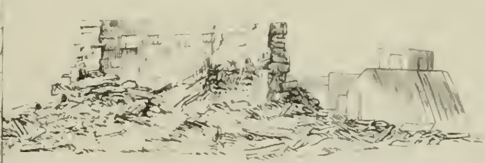
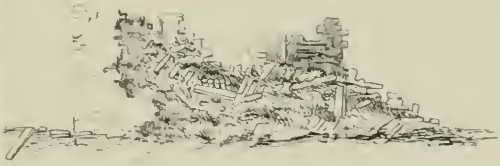


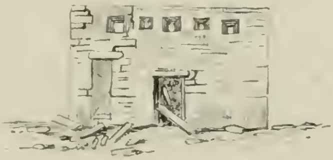
North



East



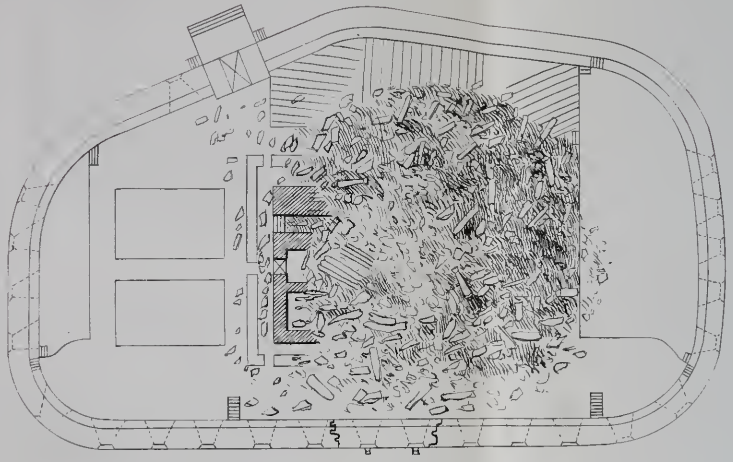
South



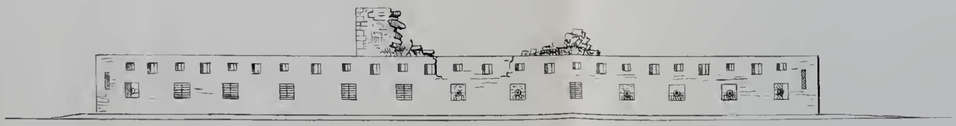
West

Standidge & C° Lith. London

Plan, South Elevation, and Sketches of the Four Sides of the KEEP.
after the Explosion, 5th April 1847.



Plan.



South Elevation

North

East

South

West.

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PAPER VI.

CIRCULAR INSTRUCTIONS to the COMMANDING ENGINEER.

THE original copy of the following document was left at Corfu by the French, when they evacuated the island in 1814. Its date shows that it was drawn out after the French army had been destroyed in Russia, and when the fortresses on the Vistula and the Oder were in a state of siege. The translation was made from a copy of it certified and sent to Lieutenant-Colonel Pasley (now Major-Gen. Sir Charles Pasley) by Lieutenant Charles Wright, of the Royal Engineers, and lithographed at the Royal Engineer Establishment, Chatham. It is again brought forward, as being a useful summary of the principal points to be attended to, in drawing up a report on the state of a fortress.

LETTER of the FIRST INSPECTOR GENERAL of ENGINEERS to the DIRECTOR of FORTIFICATIONS.

Paris, 15th April, 1813.

DEAR SIR,

The 86th Article of the Imperial decree of the 24th December, 1811, directs that there shall be sent into all the fortresses, to be deposited in the archives of the place, a report which shall point out the state and means of defence of the fortress, as well as the part it might bear in offensive or defensive operations on the frontier, or on the sea-coast.

This memoir, which is more particularly intended for the use of Commandants, should show the actual state of the defences of the fortress in the most minute detail.

The materials which exist in the Depôt of Fortifications furnish, on many points, but very incomplete information. I therefore send you a copy of the form I have adopted by making out such reports.

Should you not have time yourself to put this report in proper form, or be able to get it done, you can send me the original materials for it containing the information required. A copy or an abridgment of the papers you transmit will be made out by my order in the Depôt of Fortifications according to the proper form, and will be sent to you immediately afterwards.

Je vous salue, &c.,

(Signed) CONTE DEJEAN.

An Historical Memoir of the Present State and of the Defences of the Fortress of ———— and its Dependencies; intended to show its State of Repair, its Advantages or Disadvantages, as well as those of its Outworks; and what Connection it may have with the neighbouring Fortresses, or with offensive or defensive Warfare.

Drawn up in conformity with Article 86 of the Imperial Decree of the 24th of December, 1811, for the purpose of being deposited in that Office of the Fortress which is to contain the Maps and Plans ordered by the same Decree.

CHAPTER I.

The History of the Fortress as it relates to the Defence, and containing a Chronological Account of the Military Events in which it has taken any part.

(Remark what are the best books to furnish material for this history, and if there has been nothing published on the fortress, give all the necessary information to complete this chapter.)

CHAPTER II.

A Concise Descriptive Sketch of the actual State of the Frontiers, of which the Fortress forms a part. Its Topography, its Situation, and the part it might act in the Defence of the Territory.

(The title alone of this chapter is sufficient to show the information it must give.)

CHAPTER III.

Description of the Fortress, and of its Environs, and the Resources which they may afford for the Provisions and Supplies of every Kind.

(Contained under three Articles.)

Article I.

The description of the Fortress.

(Divided into two Sections.)

Section First of Article First.

The Fortification.

(Divided again into four Paragraphs.)

1st. Of the Main Enclosure.
2nd. Of the Outworks.
3rd. Of the advanced Works.

(This description should comprehend all existing works, and such of those ordered to be constructed as are on the point of being finished; that is, an exact report of the state of the fortress, of its outworks, and advanced works, explaining the purpose for which each several work of the fortress is destined; the state of the countermines, and the purposes for which they are intended; the bridges actually constructed, and those which it would be necessary to form in the cases of the different supposed attacks; the rafts or boats which should replace them under certain circumstances, in order to communicate with the outworks, the posterns to be formed in order to secure communications, &c.)

4th. Inundations, Sluices, Dykes, Batardeaux, &c.

(In maritime fortresses, and such as are susceptible of being protected by inundations, indicate in a clear manner the purposes for which the sluices, dykes, &c., are destined; whether they are for the purposes of navigation, or for defence. Explain in a precise manner the ground that may be flooded, the means of forming the inundations, and the time required for that purpose; whether they could be drained or not; whether they favour navigation or machinery, or otherwise, &c.; also the obstacles or delays which either the season, or the presence of an enemy, might cause to their formation; and lastly, the means by which an enemy might drain them.)

Section Second of Article First.

The Interior.

(Divided again into five Paragraphs.)

1st. Of Military Buildings and Establishments.

(Here show the situation, the number, and the description of military buildings, the purposes for which they are intended, and how they are occupied. State the use they would be made of in case of siege. State whether the bakehouses are under bomb proofs, and if not, what means are required to make them so, or to place them in proper casemates; make known also the state and capacity of the casemates.)

2nd. Of other Public Buildings and Establishments.

(State such as might be occupied in case of necessity with advantage to the defence, after making the necessary alterations. Report what resources of this description could be obtained from private houses, and particularly from their cellars.)

3rd. Of the Squares, Esplanades, and other places most favourable for assemblies, or for making depôts of Wood and Forage.

(Consider these places with regard to the number of troops that could be formed there, and whether they would favour the formation of unlawful assemblies. Point out also the least exposed situations, and those most proper for the formation of depôts of wood and forage.

4th. Of Streams of Water through the place, Bridges, Basins, Fountains, &c.

(Make known the resources which they afford to the fortress; state the rivers or canals which pass through the town, as they may be connected with the defence, if they would facilitate the operations of gun-boats. In towns where there are no streams or river-water fit to drink, state whether the provisions are sufficient, and not liable to be turned off; whether, in such a case, the wells would be sufficient, or whether it would not be necessary to form cisterns, &c.)

5th. Of the Population.

(This article is intended to show what use may be made of the inhabitants in the defence of the place, or in the construction of the works, and it ought therefore to show the number of men which might be usefully employed.)

Article II.

Description of the Environs.

(Divided into three Sections.)

Section First of Article Second.

Of the Circle of Attack.

(State the nature of the ground round the fortress, and the spot which is most favourable for the opening of the trenches. This description ought to make known such undulations of ground as are either favourable or detrimental to defence.)

SECTION SECOND OF ARTICLE SECOND.

Of the Circle of Investment.

(In describing the ground within the circle of investment, explain what difficulties, or what resources, the enemy would meet with for his camp, or in the formation of his lines of circumvallation and countervallation.)

SECTION THIRD OF ARTICLE SECOND.

Of the Circle of Action.

(This article should explain what posts and positions the garrison might occupy, and the fortresses they could communicate with. It ought to contain an account of the roads, canals, rivers, and other particulars which might either confine or favour their communications.)

ARTICLE III.

Of the Resources which the Environs of the Fortress might afford as to Provisions and Materials.

(Divided into two Sections.)

SECTION FIRST OF ARTICLE THIRD.

Of Provisions and Forage.

(State what the environs of the place might furnish (in a moment of pressing necessity) in grain, flour, liquor, cattle, forage, &c., as subsistence for the fortress, and what would be the most speedy means of collecting them.)

SECTION SECOND OF ARTICLE THIRD.

Of Timber of all Descriptions.

(State the quantity of wood for fuel, gabions, fascines, pickets and hurdles, for palisades, blinds, bridges, &c., which might be procured from the country in the neighbourhood. Give in detail an account of the wood of every description necessary for a state of siege, and report what forests or woods it might be most easily obtained from, and at the lowest prices, as well as the cheapest and quickest way to fell, transport, and convert it.)

CHAPTER IV.

Of the Defence of Fortresses.

(Contained under two Articles.)

ARTICLE I.

Of the Defence against Irregular Attacks.

(Divided into seven Sections.)

SECTION FIRST OF ARTICLE FIRST.

Of Surprises.

(State what points might favour a surprise, and which are the most important to watch.)

SECTION SECOND OF ARTICLE FIRST.

Of Escalades.

(The same observations as in the above.)

SECTION THIRD OF ARTICLE FIRST.

Of an Attack by Main Force by the Petard.

(State the places most exposed to this sort of attack, and the precautions which ought to be taken to guard against it.)

SECTION FOURTH OF ARTICLE FIRST.

Of a Bombardment.

(State how far the place has to dread this species of attack, and the resources which it contains to secure itself against it.)

SECTION FIFTH OF ARTICLE FIRST.

Of a Blockade.

(State the resources which the fortress and its environs possess for resisting this sort of attack.)

ARTICLE II.

Of the Defence against a Regular Attack or Siege.

(Divided into four Sections.)

SECTION FIRST OF ARTICLE SECOND.

Of the Investment, Camp, and Lines of the Enemy.

(State, according to local circumstances, the obstacles which the enemy may meet with, and the means that should be employed for embarrassing him in these operations.)

SECTION SECOND OF ARTICLE SECOND.

Of the Opening of the Trenches and Parallels.

(The point best adopted for the opening of the trenches being determined, state the difficulties that the enemy may meet, and the resources of the besieged for retarding his approaches.)

SECTION THIRD OF ARTICLE SECOND.

Of the Attack and Crowning of the Covered Way.

(State, according to local circumstances, the means there may be of retarding this period of the siege, and of rendering it destructive to the enemy.)

SECTION FOURTH OF ARTICLE SECOND.

Of the Descent and Passage of the Ditches of the Outworks.

(In following step by step the operations of the enemy, state the obstacles he ought to meet with, and the resources which the works afford to retard his progress.

SECTION FIFTH OF ARTICLE SECOND.

Of the Breaches and Assaults, the Advanced Works and Outworks, and Lodgments on the Breach.

(Similar to those of the last Paragraph.)

SECTION SIXTH OF ARTICLE SECOND.

Of the Breach, Passage of the Ditch, Assault and Lodgment on the Body of the Place.

(State the difficulties which the enemy must vanquish, in order to be able to come to the assault, and the means for repulsing him, or preventing him from forming his lodgments in the body of the place.)

Section Seventh of Article Second.

The Retrenchments and Capitulations.

(As a Commandant can never be authorised to capitulate until he has resisted to the very last extremity, state the means to be employed for prolonging this resistance by means of retrenchments constructed behind the breach.

CHAPTER V.

Of the Fortress, as it is connected either with Offensive or Defensive Warfare.

(Divided into three Articles.)

Article I.

Of Detachments and Reconnoitring Parties, and of the Surprise of Parties of the Enemy.

(The topographical situation of the town with relation to the neighbouring fortresses, or to the frontier, and the nature of its locality, must determine the part the garrison can act under such circumstances.)

Article II.

Of Escorts, Convoys, Removal of Sick and Wounded.

(The communications more or less easy with the neighbouring fortresses, the strength of its garrison, and the nature of its establishments, have their influence upon the protection which it may afford to our convoys, and the resources it may possess for the removal of sick or wounded.)

Article III.

On the Attack of the Enemy's Convoys, and of Harassing his Columns in a Retreat.

(State the resources which the fortress may afford, whether it be by its positions or by its garrison, for intercepting the convoys of the enemy, or for harassing him in a retreat.

PAPER VII.

ADDITIONS to the BARRACKS at FORTON, to accommodate the PORTSMOUTH DIVISION of ROYAL MARINES. By Capt. JAMES, R.E., F.R.S.

THE barracks formerly occupied by the Royal Marines in the town of Portsmouth being very much out of repair, and not affording the accommodation required by the Division, either for the officers, the men, or parade-ground, and its cramped position between the ramparts and the houses of the town not admitting of such enlargement or alterations as were required, the Lords of the Admiralty directed me to select a site, and make a design for a new barracks, to accommodate 1000 men in barracks, with all the necessary quarters and offices required for the Division.

The site which I proposed for the barracks was the field between the Royal Clarence Victualling Yard and the lines of Gosport.

Negotiations were commenced for obtaining this site from the Ordnance, which, after some delay, was met by a counter proposition on the part of the Ordnance, viz., to exchange the barracks at Forton, outside the lines of Gosport, for the Old Marine Barracks in Portsmouth. This proposal was accepted, and the exchange soon after effected.

I was then directed to design such additions at Forton Barracks as would be necessary to give accommodation for the full Division, which consists of—

1 Colonel Commandant.
1 Colonel 2nd Commandant.
4 Lieut. Colonels.
1 Barrack Master.
1 Paymaster.
2 Adjutants.
2 Quartermasters.
1 Surgeon.
1 Assistant Surgeon.
12 Captains.
24 Lieutenants.
2 Serjeant Majors.
1 Quarter-master's Serjeant.
1 Barrack Serjeant.
1 Adjutant's Chief Clerk.
1 Paymaster's ditto.
1 Armour Serjeant.
1 Band Master.
60 Serjeants.
50 Musicians.
1000 Men.

I was subsequently ordered not to provide accommodation for the barrack-master, paymaster, or surgeon, who were to receive lodging-money allowance, and reside out of the barracks.

The barrack at Forton is one of the finest in England, and in accepting the offer of exchange, the expenditure of the large sum of money which would have been required for new barracks was avoided.

The barrack, when transferred, consisted of the four pavilions numbered 1, 2, 3, 4, on the plan, and was capable of containing 48 serjeants, and 832 men; but as the lower part of pavilion 4 was occupied as a mess establishment for the officers, and pavilion 1 as a surgery and hospital, and part of the other pavilions were occupied as school-rooms, tailors' shops, barrack-master's and quarter-master's stores, the accommodation for the effective force was limited.

The officers' quarters, 5, 6, were also quite inadequate for a Division of the Marines, and only afforded accommodation for one field-officer, two captains, and the subalterns. It was therefore decided to appropriate the four pavilions exclusively to the men, which would then accommodate 833 men and 24 serjeants, and 24 staff serjeants in the projecting parts of the buildings in rear of the pavilions; and to build an additional wing (No. 35) to accommodate the remaining 158 men, and the remainder of the serjeants; but the construction of the additional wing has been counter ordered, at least for the present.

The new mess establishment (20), the captain's quarters (22, 22), the field officers' quarters (21, 21, 21, 21), and the paymaster's offices (23), have been built, and also schools for 50 boys and 50 girls at (24). Also offices for the Commandant, Adjutant, orderly room and court-martial room at (25), and the guard-room enlarged at the entrance, over which a clock has been placed.

At the time the barracks were transferred to the Admiralty, two rows of wretched houses occupied the position of the school-rooms and offices; these were purchased and pulled down; and that the barracks might be kept clear of houses along its front, the field opposite the gate was purchased. This is an admirable site for a barrack hospital, a design for which I furnished, as directed.

The quarter-master's stores, tailor's and shoemaker's shops, are in the buildings (26). The armourer's shop and armourer-serjeant's quarters are in (27). All these buildings, and a covered practice-battery a little to the north of the barracks, were constructed under my superintendence, and from designs furnished by me; the remaining buildings are in course of construction, under the superintendence of my successor, Captain Mould, R.E. They are: mess-room, library and kitchen for the serjeants, and library for the men, at (28); barrack-master's stores and offices at (29); cookhouse and bakery, with practice-room for the band, at (30); the lavatories for the men, at (31, 31), with cleaning sheds for accoutrements behind; sutler's shop, at (32); fives-court, at (33); new wash-house, (11); and additions to the canteen.

The house occupied at present by the Commandant, being held by a lease which expires in 1853, the construction of his residence (36) has been postponed till that time; and I understand that the design for it, which I furnished, and which was in unison with the other buildings, has been altered, and the uniformity of character in the buildings destroyed.

Plate 2 represents the ground plan, and Plate 3 the plan of the first floor of the mess establishment; field-officers and captains' quarters, and of the pay-offices, which are in one block of buildings. Plate 4 is the elevation of this block of buildings, which, like the previously existing buildings, is of brick, with Portland stone for the cornices, doors, and windows. The terrace in front of the building is covered with asphalte, the coping of the dwarf retaining-wall, and the steps, are of grey granite.

Mess Establishment.—By reference to the strength of the Division, it will be seen that it consists of 50 officers, for whom, and the large number of visitors which, on such occasions as an inspection by the Lords of the Admiralty, and the many other festive occasions on which the Division is called upon to show its hospitality, it was necessary in designing the mess arrangements to provide accommodation; it was also necessary to provide an orchestra for about 30 men of the band; and knowing the extreme inconvenience and annoyance of having such a large number of men in a mess-room, where the music is always too loud, and where the addition of so large a number of men to the company increases the oppressive heat of a large party, I designed an orchestra in a recess in the well of the staircase, immediately over the first flight of steps, and on a level with the floor of the mess-room, giving the back of the orchestra and the top of the recess a concave form, so as to throw the full sound of the music into the door of the mess-room. This arrangement will be seen by reference to Plate 5, which is a section through the centre of the building; and Plate 6, which is the elevation of the staircase and orchestra. The band is thus entirely separated from the company, and enter, as the servants do, by a separate door and staircase.

The effect of this arrangement has been beyond my most sanguine expectations. The music is perfectly heard in every part of the mess-room, and the company is freed from the great discomfort of having such a number of men in the room; whilst, from the position of the band, their presence adds greatly to the effect of the architectural appearance of the handsome staircase of Portland stone.

Major-General the Right Honourable Lord Frederic Fitzclarence, the Lieut-Governor of Portsmouth, whose knowledge and taste in such arrangements is appreciated by all who have the honour of his acquaintance, has informed me, by a note through his aide-de-camp, Major Harvey, that he considers this arrangement "perfection for its purpose." Colonel Menzies, the Commandant of the Royal Marines, says, "The general arrangement of the mess establishment is the theme of admiration, and I consider the whole to be faultless."

I have been thus particular in describing the arrangement of the orchestra, because I have felt that a good arrangement of this kind is a desideratum for mess establishments in general, and in the hopes that these plans may be of assistance to others having to make similar designs.

The mess-room is 55 feet long, 31 feet wide, and 22 feet high, with fine lofty windows looking on the parade; a handsome cornice and ceiling, and two white veined marble chimney-pieces, one at each end; the floor is supported by two wrought-iron girders, and by the walls of the entrance passage. From 70 to 80 people can dine in this room with perfect comfort. Below the mess-room there is a library and a breakfast-room for the officers: these are each 29 feet long, 21 feet wide, and 14 feet high, and are sufficiently large for the officers to dine in one of them, when their numbers are much reduced. The kitchen corresponds in size with the rest of the establishment. It is 38 feet long, 21 feet wide, and 23 feet high, with a lanthorn and ventilators in the roof to carry off the steam and odours incidental to the cooking of large dinners. The great height given to the kitchen, and the three large windows in it, was to secure as much light and air in it as possible, as these are the great essentials for cleanliness; and the kitchen is so far placed from the officers' rooms, that the smell of cooking from it cannot reach them, whilst it is sufficiently near to admit of the dishes being brought up hot by the servants' staircase.

The kitchen is provided with all the requisites necessary for cooking a dinner for 100 people, and with steam closets for keeping the dishes hot. Arched cellars, for wine, beer, and coals, are under the library and breakfast-rooms; access to them, and facilities for shooting the coals, and lowering the barrels, being provided at the rear of the building.

The accommodation given to the field officers and captains will be seen by the plans and elevation; the kitchens are in the basement story, each captain having one in addition to his sitting-room and bed-room. An ample supply of excellent water is obtained from a well in the rear of the building. A fatigue party of 4 or 5 men can fill, by means of a three-throw pump, the cistern that supplies the Quarters, in about half an hour.

Owing to the great number of detachments of Marines which are serving in men-of-war in all parts of the globe, and the great strength of the Division, the offices for the paymaster are necessarily on a large scale; the men present with the Division are paid by 4 pay-serjeants, at windows in the offices opening into a wide passage on the ground floor; the paymaster and his clerks have offices over these.

The estimated cost of the principal block of buildings was 14,000*l.*, exclusive of the fitments and furniture, and it was not exceeded.

The following remarks appeared in the *Portsmouth Times* of 11th January, 1851, and were copied very generally into other papers. I have not the least idea who the representative of the editor, or the gallant veteran officer alluded to, may be. "We scarcely know which to admire most in the structure, from the descriptive report furnished by our representative, who was escorted over the building on Wednesday by a gallant veteran officer and the contractor. To begin, however, with an effort, the cellarage is ample enough to contain stock for a siege three times the length of that of Troy, if compulsory. The kitchen is replete with every appliance of modern art and culinary perfection, lofty, commodious, and healthy; even the palace of the Sovereign is not better supplied with the necessaries and auxiliaries of the *cuisine* to a more glucous extent. The arrangements of the pay department are unique, but must be inspected to be understood and properly appreciated. The field-officers' and subalterns' quarters are as ample and elegant as a generous commission could design, and yield the most general satisfaction. The grand entrance to the mess-room is capacious and classic in its design, and exhibits in its external features the welcome to its hospitalities within. Branching off on either side of the entrance-hall, are handsome proportioned dining-room and library, large, well-lighted, and in suitable keeping with the grandeur above. Facing the hall of entrance, a gallery for the accommodation of the band of the Corps has been erected, and proved to be admirably placed for giving effect to the performances of the talented occupants. Ascending the grand staircase (and it is grand in the truest acceptation of the term), we arrive at the banqueting-room of the Corps, a right regal hall of state, whose proportions are commensurate with the extent of the hospitality known to be so generally exercised by the Royal Marines. When equipped, this banqueting-room will be the most magnificent of the kind in the kingdom, and most probably out of it. The Commandant's offices, on the right of the entrance-gate to the parade-ground, and those of the non-commissioned officers in connection with it; also the adjutant's room, court-martial room, orderly room, the school-rooms for boys and girls, and residences for master and mistress, on the left of the entrance, &c., &c., present features of accommodation and convenience which no official can occupy, or visitor behold, without being impressed with the everywhere apparent fact of the utmost convenience and comfort having been studied in this removal of the Royal Marines to Forton, where they may now be considered as established *en permanence.* All unite in giving the Admiralty the warmest praise for their generous bounty and consideration, in so handsomely berthing their gallant representatives in arms. First cost is generally least, and assuredly it was far better and more

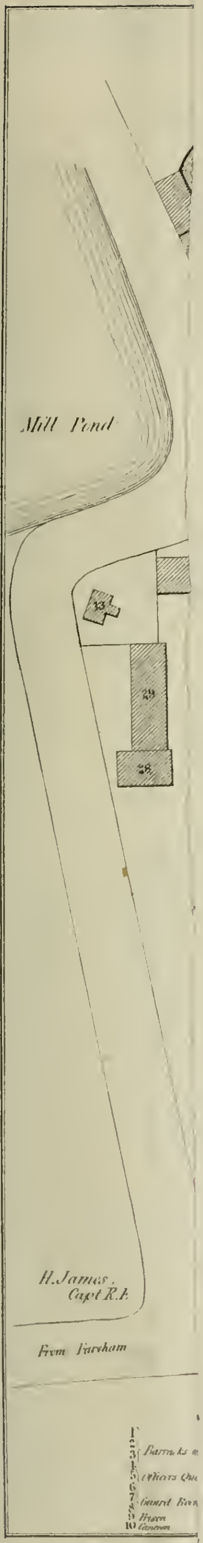
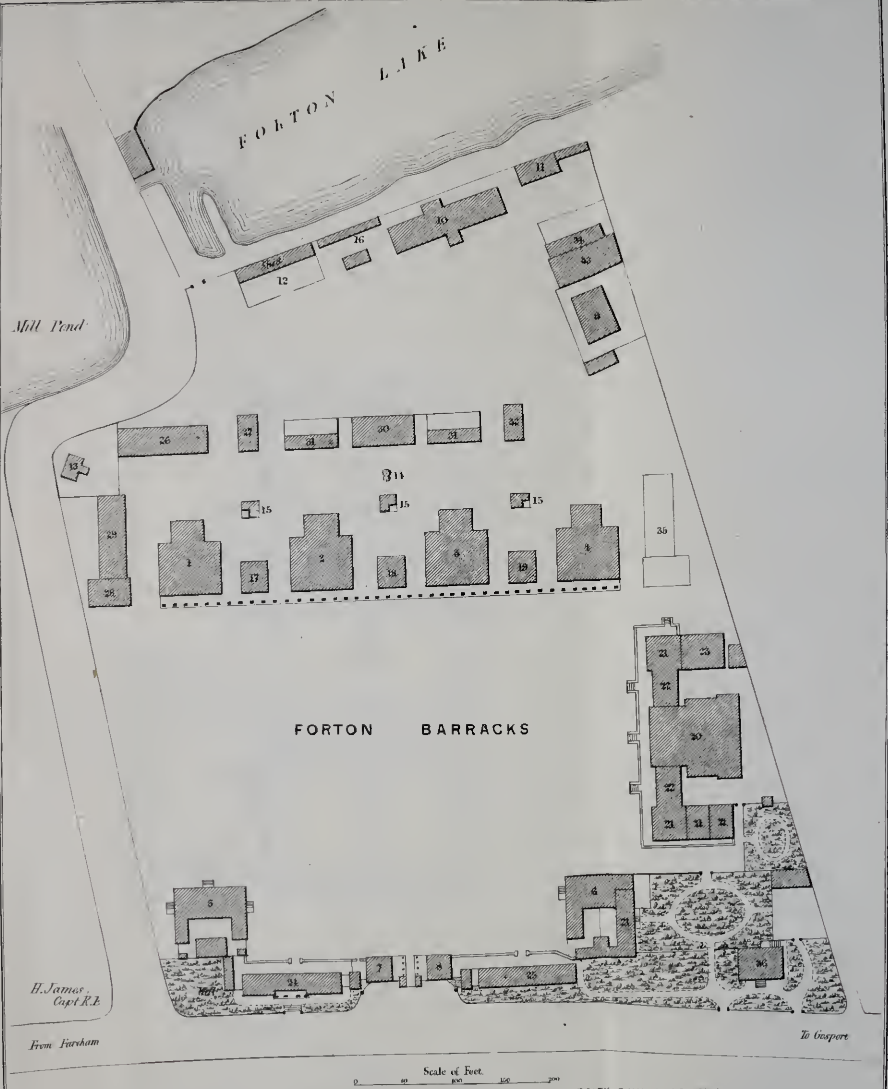

Mill Pond
13
29
28
H. James.
Capt R.E
From Fareham
1
2
3 Barracks
4
5 Officers Qu
6
7 Guard Ro
8
9 Prison
10 Canteen

PLATE I.



ORDNANCE BUILDINGS (Old)

1
2
3 Barracks for N.C. Officers and Soldiers
4
5 Officers Quarters
6
7 Guard Rooms
8
9 Prison
10 Canteen

11 Wash House
12 Coal Yard
13 Magazine
14 Pump
15 Tanks and Fire Engines
16 Privy
17 Cook House
18 Barrack Serjeant
19 Orderly Room

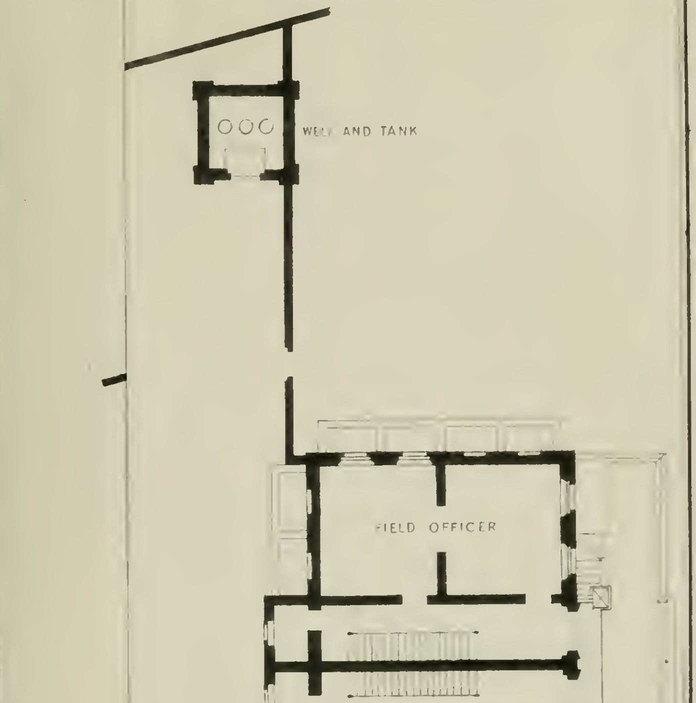
ADMIRALTY BUILDINGS (New)

20 Mess Establishment for Officers
21 Field Officers Quarters
22 Captains Quarters
23 Paymasters Offices
24 Boys and Girls School
25 Commandant, Adjutant and Orderly Offices and Court Martial Room
26 Quartermasters Stores and Tailors and Shoemakers Shops
27 Armorer Serjeants Quarters and Armory
28 Serjeants Mess and Library and Privates Library

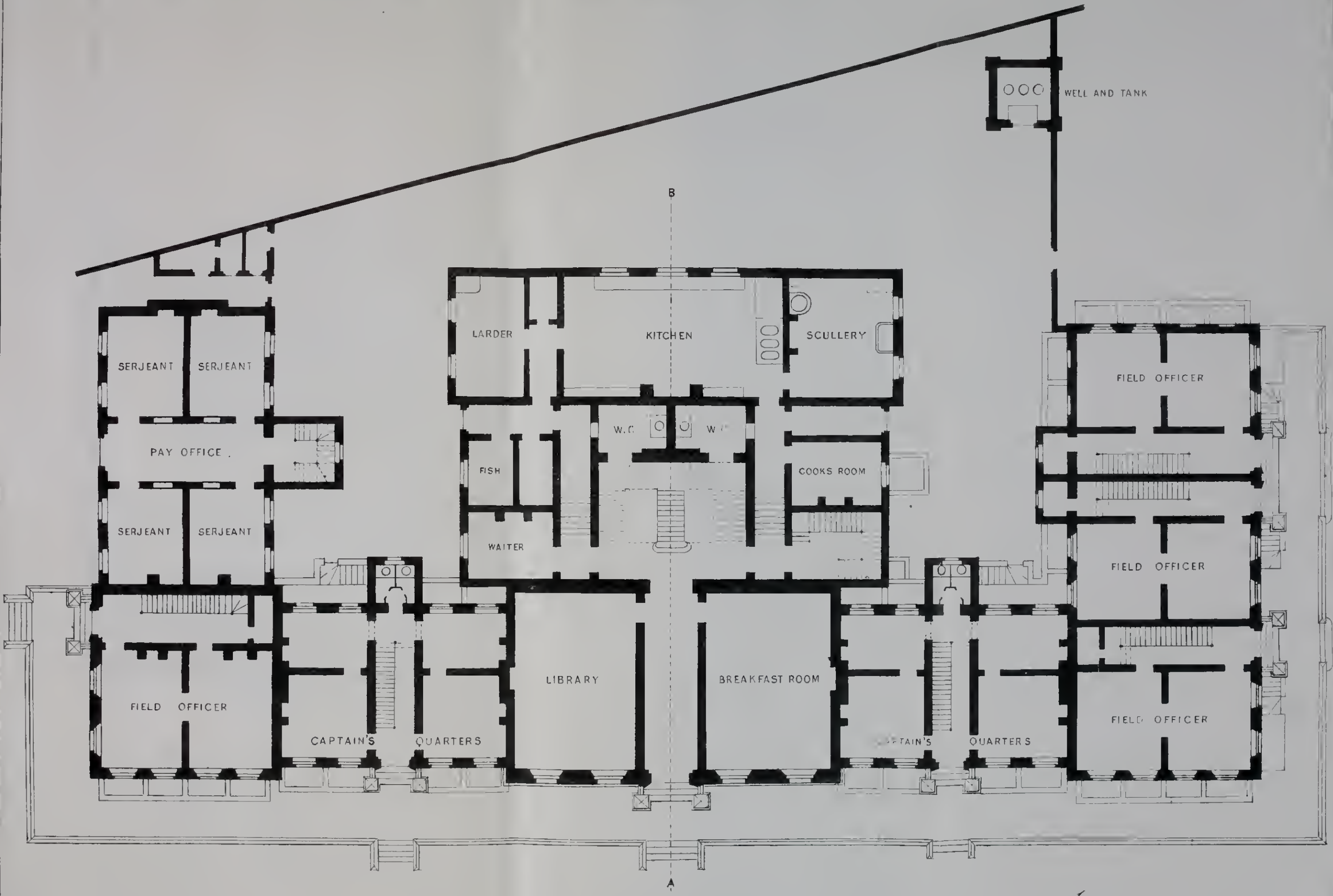
29 Barrack Masters Stores
30 Cook House Bakery and practice room for Band
31 Lavatories and Cleaning Sheds
32 Sutlers Shop
33 Fives Court
34 Officers Stables
35 Barracks for Soldiers
36 Commandants Residence

Standidge & Co Litho Old Jewry

Plate 2



J Hames.
Cap R.E.

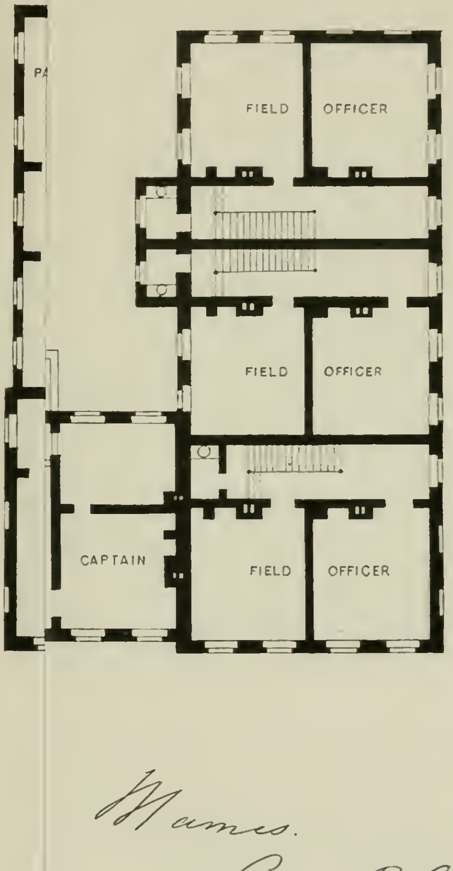


GROUND PLAN
of Mess Department & Officers Quarters.

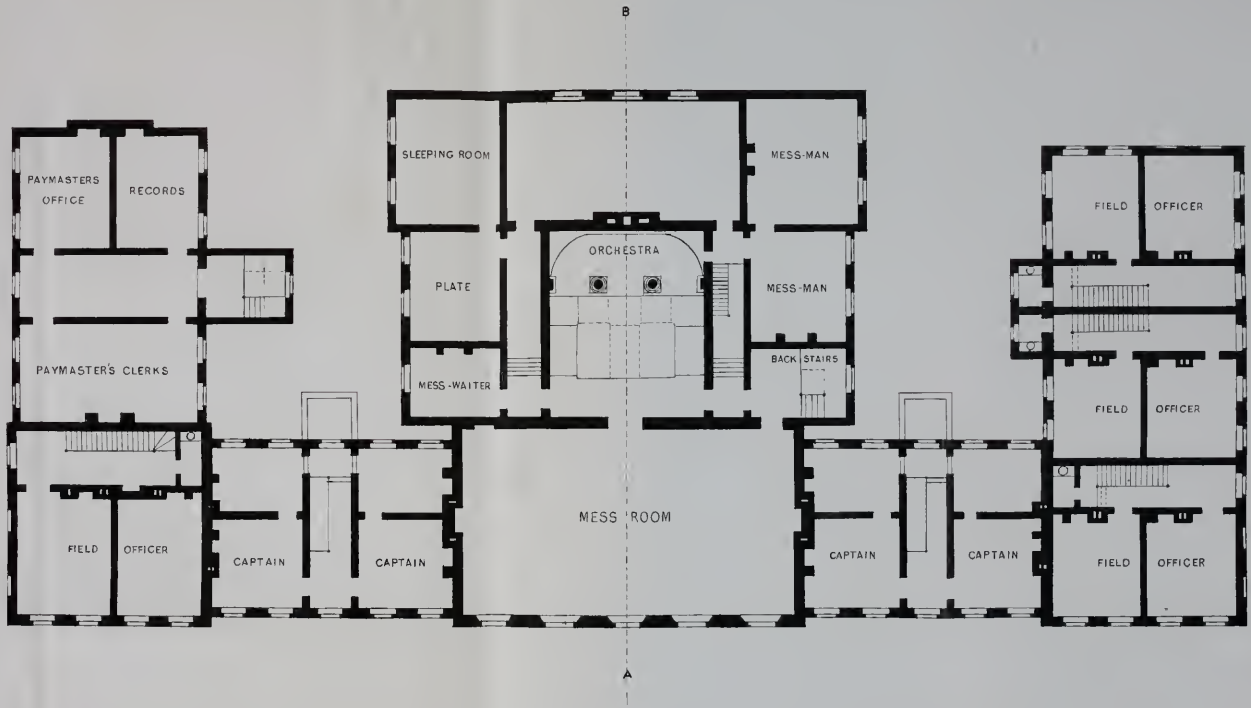
10 5 0 10 20 30 40 50 60 Feet

Standidge & Co Litho Old Jewry

H James.
Cap. R.E.



H James.
Cap. R.E.



FIRST FLOOR.

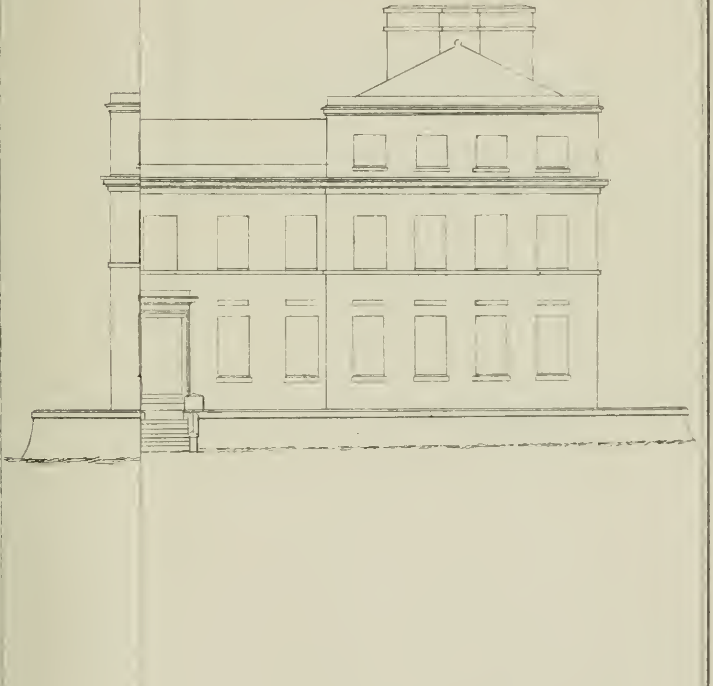
of Mess Department & Officers Quarters.

10 5 0 10 20 30 40 50 60 Feet

Standidge & Co litho Old Jewry

H James.
Cap. R.E.

PLATE 4.



H. James,
Capt R.E.

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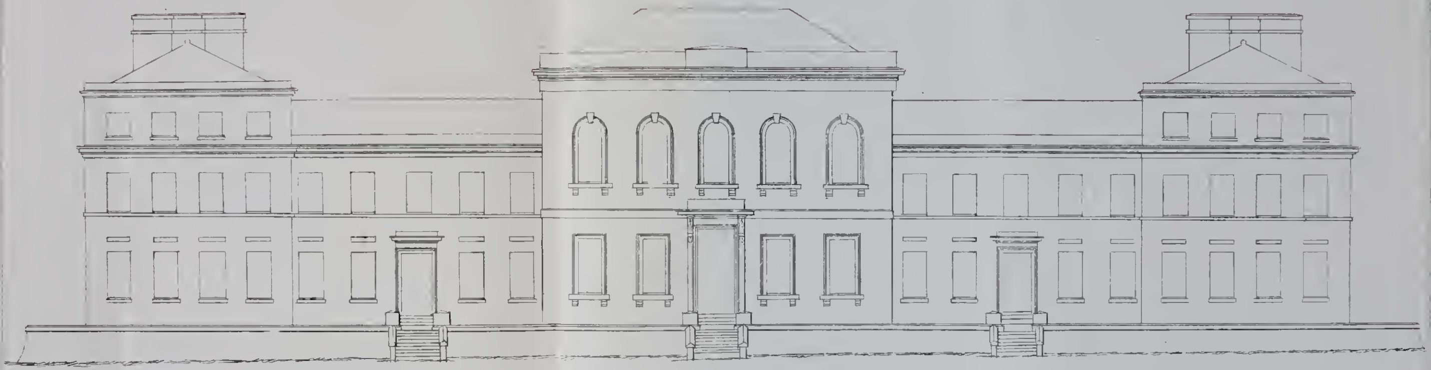

ELEVATION
OF
MESS DEPARTM^T AND OFFICERS' QUARTERS.

H. James,
Cap^t R.E.

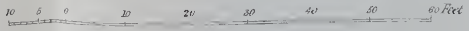

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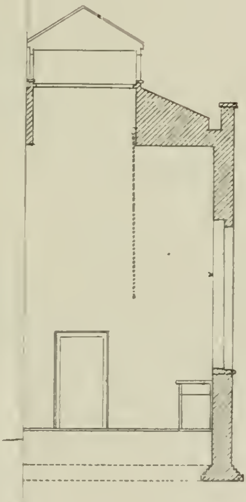
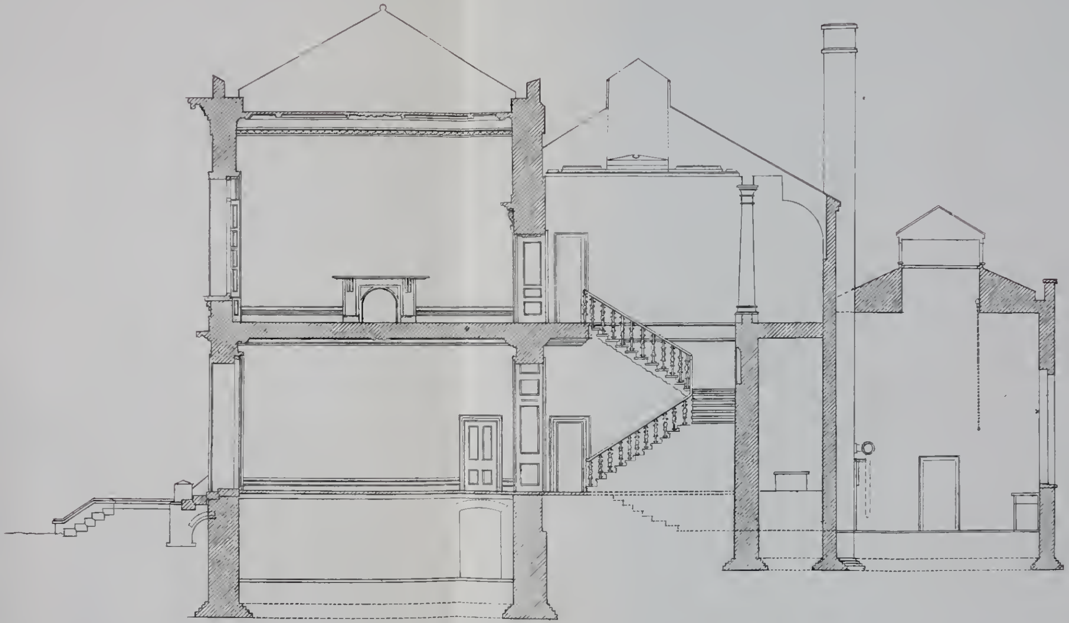
PLATE 5.



H. James,
Capt R.E.

Standidge & Co. Litho. London.

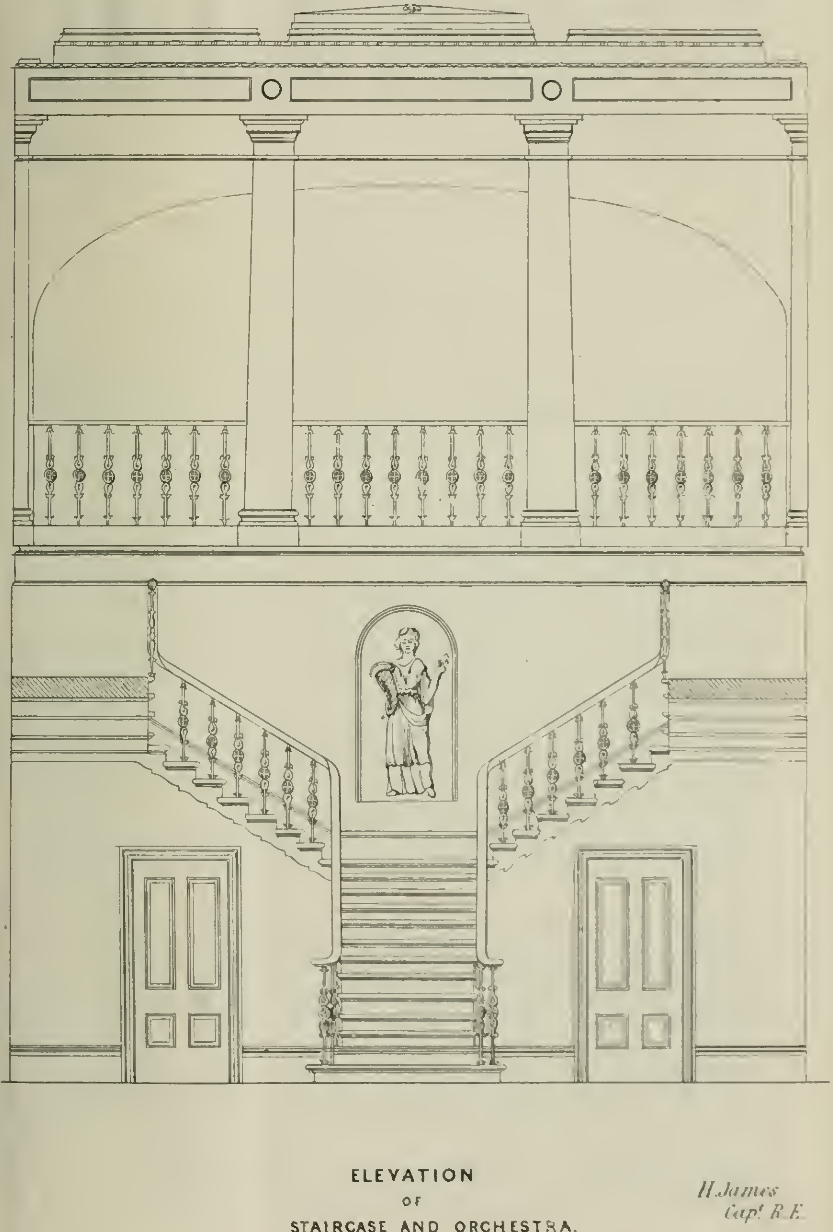
Section on the line A.B. *Plates 2 and 3.*



TRANSVERSE SECTION.

H. James,
Capt R.E.

Standidge & Co. Litho. Londn.



ELEVATION

OF

STAIRCASE AND ORCHESTRA.

H. James
Capt. R.E.

12 9 6 3 0 1 2 3 4 5 6 7 8 9 10 Feet

[illegible]

economical in the Admiralty thus to expend a little more at starting in this matter, than, by botching up a heterogeneous mass of shapeless buildings (which on the first exigency for increased accommodation would have to be pulled down), pay, after all, through the nose for the requisite accommodation."

I have great pleasure in availing myself of this opportunity to acknowledge the valuable assistance I received from Mr. Crew, the Clerk of Works, who superintended the execution of the work under my direction.

H. JAMES,
Capt. R.E.

PAPER VIII.

By Major-General G. G. Lewis, C.B., R.E.

De la Defense Nationale en Angleterre. Par le Baron P. E. Maurice, Captain du Génie de la Confédération Suisse, Ancien Elève de l'Ecole Polytechnique, &c. &c. 1851.

This work of the current year serves to keep alive the attention of military men to the defenceless state of Great Britain; and the notice gives the compiler of this paper an opportunity of recurring to his previous inquiries on this subject. (See the 9th and 10th Volume of "Professional Papers," Quarto Edition.)

In regard to M. Maurice's propositions, embracing, first, the opinions of different persons who have published their different schemes for the defence of our coasts, and our resources; secondly, the preparations for the attack and defences of England in 1803; the resources of France and England in 1850, and the chances of success of the former, with the present state and defence of the latter; lastly, M. Maurice's inquiries into the best mode that England should follow, whether to fortify the coast, or secure London by detached forts, or by an enceinte continué, or to have recourse to entrenched camps.—It is proposed to extract such portions as are new, and to give them in the author's own words, and not to discuss the value or the accuracy of his propositions; and then to recur to the compiler's former opinions and suggestions for the defence of the South Coast of England.

"1°. Quand Napoléon conçut son plan d'invasion, il dut choisir une base d'opération étroite, parce que, ne disposant que de moyens de transport d'un très petit tonnage et très peu capables de résister à un gros temps, il lui fallait choisir la ligne de traversée la plus courte. Avec la vapeur la question change de nature. La France peut prendre la côte de Brest à Calais pour sa base d'opération, et choisir ses points de débarquement.

"Supposons pour un moment que les deux grands ports militaires français de la Manche seront les points de départ des escadres de l'armée d'invasion, cherchons les distances moyennes de ces ports à certains points des côtes d'Angleterre, et d'abord occupons-nous à déterminer ces points.

"En suivant la côte est-sud-est de l'ile, du Nord-Foreland au cap Lizard, les points plus ou moins fortifiés sont: Sandgate, Deal, Douvres, Walmer, Hythe, Eastbourne,

Dean-Church, Portsmouth, Dartmouth, Falmouth, et Plymouth ; et du Nord-Foreland à l'embouchure de la Tamise, Sheerness, Chatam, et le fort Tilbury, sans parler des tours Martello construites sur quelques points du littoral, mais qui sont plutôt des sentinelles garde-côtes que de vraies fortifications. Évitant donc autant que possible d'aborder ces points fortifiés, à l'exception d'un des ports militaires, dont, suivant nous, il importe (ainsi que nous le verrons plus loin) de s'emparer dès le commencement, nous trouverons les distances suivantes :

“ De Brest .
à Plymouth, 266 kilom. *, ce qui, à 16 kilom. par heure de navigation à la vapeur, donne une distance de 17 heures.
à l'embouchure de l'Avon, 433 kilom., ce qui donne une distance de 27 heures.

“ De Cherbourg
à Rye, 222 kilom., ce qui donne une distance de 14 heures.
à Portsmouth, 133 kilom., ce qui donne une distance de 8 heures.

“ Le maximum de temps nécessaire pour franchir ces distances est donc de 27 heures ; mettons-en de 30 à 34, à cause des retards qui entravent toujours les convois un peu nombreux.

“ Munis de ces données, nous croyons qu'il serait avantageux pour la France de choisir trois points de débarquement. Le premier serait à l'embouchure de l'Avon, de manière à établir immédiatement le corps d'armée de l'aile gauche à 6 étapes de Londres. La ligne d'opération des Français de l'Avon à la Tamise, vers Londres, tend ainsi à couper les communications des comtés du nord avec ceux du sud-ouest, et force les Anglais à diviser leurs forces ; le second serait en arrière de Plymouth qu'il faudrait assiéger du côté de terre, parce qu'il importe d'occuper un port militaire pour y protéger la flotte de débarquement contre les attaques de la flotte anglaise, et pour s'établir fortement dans le pays, dès l'entrée en campagne.—Plymouth est plus rapproché de Brest que Portsmouth ; il est moins bien défendu, et sa prise fait tomber nécessairement entre les mains de l'assaillant les places de Dartmouth et de Falmouth, le Devonshire et la presqu'île du Cornouailles, pays abondants en grains, en pâturages, et en chevaux. En outre de Plymouth à Bristol, il n'y a que 155 kilomètres, ce qui permettra au corps d'armée de l'aile gauche de se mettre en communication avec celui du centre. Enfin la forêt de Dartmoor fournira d'abondants approvisionnements à l'armée pour la confection des gabions, saucissons, clayonnages, et bois de construction de toute sorte qu'exigera le siége de Plymouth. Le troisième point de débarquement serait la côte et le nouveau port de Rye.—Rye est à 96 kilomètres, soit 3 étapes de Londres ; c'est un des points les plus rapprochés de la métropole ; le corps d'armée principal qui débarquerait en ce point, formant l'aile droite de l'armée d'invasion, devrait porter tout son effort directement sur Londres. Mais, dira-t-on peut-être : Pourquoi ces trois points de débarquement au lieu de réunir toutes les forces agressives sur un seul point ? Parce qu'une seule armée de 150 mille hommes trouvera bien moins facilement les voitures et les chevaux de réquisition nécessaires pour le transport de ses munitions, de ses parcs, et de ses vivres, que trois corps d'armée séparés. Parce que le côté faible de l'armée régulière anglaise étant son petit nombre, il vaut mieux la forcer à se disséminer et à agir contre trois assailants séparément que contre un seul tout à la fois ; il y a deux chances de plus pour l'assailant de réussir. D'ailleurs, nous n'hésitons pas à conseiller que les opérations des trois corps d'armée d'invasion soient combinées de façon à les faire marcher sur Londres *simultanément* et *concentriquement*.

“ 2°. Nous avons déjà répondu implicitement à cette question dans le paragraphe précédent.

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* A kilometre is 1093 yards.

" 3°. Nous l'avons dit : il importe d'être maître d'un port militaire important pour y abriter la flotte de débarquement, pour avoir un point d'appui solide sur le sol anglais, et pour y trouver de suite des approvisionnements en bois, en matériel, en munitions de toute sorte.

Nous avons choisi Plymouth parce que sa rade ne peut pas contenir une aussi vaste flotte de défense que celle de Spit-Head devant Portsmouth, parce que les abords de la rivière de Portsmouth, indépendamment de la grande flotte qui pourrait s'y embosser et couvrir les approaches de Portsea-Island, sont défendus, à droite, par le fort *Cumberland,* deux fortes lunettes et le *Soutseafort,* à gauche par le fort *Monkton,* en avant d'Alverstock, et par le *Blockhouse.* S'engager dans le canal du Solent pour essayer un débarquement sur la rive droite du Southampton-Water serait hasardeux, parce que le Solent est trop surveillé. Un débarquement dans le Whitesand-Bay (Cornouailles) offre plus d'avantages. Examinons, en effet, la position de Plymouth. Il est bâti au fond du Sound, entre le canal dit le *Cat-Water* à droite, et celui dit l'*Hamoaze* à gauche; ses fortifications consistent, à l'entrée de la baie, en un fort bâti vers l'embouchure du Yealm, en un fort avec batteries placées dans l'île Saint-Nicholas à 1300 mètres environ du Fisher's-Nose, où se trouve un fort bastionné qui couvre la ville de Plymouth proprement dite, et en une enceinte bastionnée très resserrée qui couvre le dockyard militaire du côté de Devonport—sans ouvrages avancés. Si l'armée d'invasion débarque à Port-Wrinckle par example (Whitesand-Bay), elle trouvera immédiatement des routes pour son artillerie et ses convois, et tandis qu'une division se dirigera par Anthony sur Corhead, où elle pourra prendre position à mille ou 1200 mètres des dockyards sur la rive droite de l'Hamoaze, une autre division pourra aller se poster sur le mont Edgecumbe, et bombarder les arsenaux et le fort Saint-Nicholas.—Dans tous les cas, en perdant un peu plus de temps, l'ennemi pourra contourner la position, et commencer régulièrement le siége de l'enceinte du dockyard du côté de la ville de Devonport, qui est sans défense aucune.

" La prise de Plymouth fait tomber du même coup tous les ports secondaires, tels que Dartmouth, Falmouth, et livre à l'armée d'invasion le Cornouailles et le Devonshire, provinces riches en blés, en pâturages, et en chevaux.

" 4°. Supposons les deux corps d'armée français débarqués, l'un à l'embouchure de l'Avon, l'autre dans le Whitesand-Bay. Supposons Plymouth attaqué à la fois du côté du nord et par la rive gauche de l'Hamoaze: une fois qu'il aura été pris et occupé, nous pensons que le corps d'armée expéditionnaire N°. 2 doit marcher sur Portsmouth, l'attaquer du côté de Gosport, et s'en emparer avant que de marcher sur Londres. En effet, la marche directe sur Londres exposerait l'armée à être prise en flanc par les troupes de la garnison de Portsmouth, à voir ses convois interceptés, ses communications coupées. Si, au contrarie, Portsmouth est pris, voilà un nouveau point d'appui très important, plus rapproché de Bristol que Plymouth, et sur lequel des convois de renforts peuvent être dirigés de Cherbourg, du Havre, et de Dieppe.

" Examinons les défenses de Portsmouth. Placée entre Portsmouth-Harbour et Langston-Harbour, l'île de Portsea est défendue au nord, comme nous l'avons dit, par une enceinte continué, et au midi par les forts Cumberland, Southsea, et par deux lunettes bastionnées, situées à 1200 mètres l'une de l'autre. Les villes de Portsea et de Portsmouth sont couvertes à l'est par des enceintes bastionnées avec demi-lunes, chemin couvert, et des fosses à l'eau. Les approches de Portsea seraient faciles pour un ennemi qui aurait pénétré dans l'île à cause des faubourgs de Kingston, Fratton, et de Southsea-Common, où il pourrait s'établir. Mais il faudrait pour y pénétrer traverser des marais, et passer à portée des hauteurs de Ports-Down, position redoubtable, d'où on aurait peine à chasser même les milices et les volontaires, qui s'y seraient retranchés avec du canon, et qui gêneraient les travaux d'approche de l'assiégeant, bien qu'à une distance assez considérable. En outre, l'armée d'invasion devrait s'emparer des forts du littoral pour ne pas être prise à revers dans ses travaux d'attaque contre Portsmouth.

" De l'autre côté du havre de Portsmouth, se trouve la ville de Gosport ; elle est protégée à l'ouest par une enceinte bastionnée simple, sans demi-lunes, ni ouvrages avancés. L'entrée du havre et du port de Gosport est défendue par le forte Monkton, le Blockhouse, et plus bas par les forts Burrow et Priddy's-Hard. A partir du fort Monkton une ligne de redans a été construite pour empêcher un débarquement dans la presqu'île terminée par Gilkicker-Point. Les défenses de Gosport sont faibles : nous n'hésitons pas à penser que l'armée, en débouchant dans la presqu'île par la route de Southampton, et se développant d'Elson à Alverstock pour commencer le siége de la ville, réussirait à s'en emparer ; Gosport une fois occupé, Portsmouth, ses docks et ses arsenaux, sont pris à dos, et doivent nécessairement se rendre, sous peine d'être brûlés.

" 5°. Nous croyons fermement que le point objectif unique des opérations des trois corps de débarquement doit être la métropole.

" Londres n'est point fortifié, comme on sait, Londres est la tête et le cœur de l'Angleterre ; c'est le centre d'où partent tous les mouvements, et où gravitent toutes les pensées et tous les intérêts du peuple anglais. ' Maître de Londres,' dit le *Frazer's Magazine*, ' l'ennemi pourrait nous imposer les conditiones les plus ignominieuses.' Londres pris, Woolwich, Chatam, et Sheerness, ne peuvent pas faire une longue résistance. Le premier de ces établissements n'a aucun ouvrage défensif ; les deux autres ont été surtout fortifiés contre des attaques venant du côté de la Tamise.

" 6°. Après les réflexions auxquelles nous venons de nous livrer, la réponse à cette sixième question devient plus facile : car il résulte évidemment de la discussion précédente que le corps d'armée de l'aile gauche ne rencontrera aucune place forte sur sa route ; il devra donc être composé d'infanterie, de cavalerie, et d'une artillerie très mobile et très nombreuse, parce qu'il aura à combattre des troupes très habiles à manier cette arme, aujourd'hui souveraine sur les champs de bataille.

" Le corps d'armée du centre devra transporter avec lui un grand parc de siége et un corps nombreux de sapeurs du génie, parce qu'il aura à faire celui de deux établissements militaires fortifiés régulièrement, quoique d'une manière incomplète. Enfin, le corps de l'aile droite qui opérera suivant la plus courte ligne menant au point objectif, devant naturellement rencontrer la plus énergique résistance, devra être aussi le plus fort en infanterie et en cavalerie ; nous lui donnerons une artillerie calculée à raison de plus de 3 bouches à feu par mille hommes, et 20 bouches à feu de siége, dans le cas où il serait jugé prudent de s'emparer de Douvres, des batteries de Hythe, et des forts de Eastbourne et de Deanchurch, pour assurer les communications de l'armée avec Boulogne et Calais, avant que de marcher sur Londres.

Voici donc le tableau de ces 3 corps d'armée ; on verra que nous avons exagéré le nombre des voitures de transport et celui des chevaux afin de ne rien négliger dans nos calculs. Nous savons qu'il n'est pas dans l'usage des Français de traîner après eux beaucoup de ces incommodes *impedimenta belli*, qu'ils se nourrissent aisément en campagne, et que la sobriété du soldat et de l'officier surtout est proverbiale. L'officier française n'a pas les habitudes de *comfort* qui suivent même en campagne l'officier anglais, et qui obligent les armées anglaises à traîner aprés elles des convois interminables.

N°. 1.—*Armée de Bristol.*

(Effectif.)

Canons.		Chevaux.
100	Cavalerie	5,000
	Artillerie de campagne	400
	Voitures, artillerie de campagne . . .	4,160
	Voitures de vivres	1,548
		11,108

	Voitures.
Artill. de campagne .	800
Vivres . . .	387
	7
	1,194

	Hommes.
Infanterie . . .	25,000
Cavalerie . . .	5,000
Artillerie . . .	1,000
Génie . . .	500
Train des équipages .	661
	32,161

"N°. 2.—*Armée de Plymouth.*

(Effectif.)

	Canons.
Artill. de campagne	100
Artill. de siége .	66
	166

	Chevaux.
Cavalerie	5,000
Artillerie de campagne . .	400
Voitures, artillerie de campagne	4,160
Artillerie de siége (à 6) .	396
Voit., art. de siége et réserve .	5,860
Voitures pour vivres . .	2,068
	128
	18,012

	Voitures.
Artill. de camp. .	800
Artill. de siége et rés.	1,465
Vivres . . .	517
Parc du génie . .	32
	2,814

	Hommes.
Infanterie . . .	25,000
Cavalerie . . .	5,000
Artillerie . . .	10,250
Génie . . .	2,000
Train des équipages .	887
	43,137

"N°. 3.—*Armée de Rye.*

	Canons.
Artill. de campagne .	250
Artill. de siége .	20
	270

	Chevaux.
Cavalerie . . .	12,000
Artillerie de camp. .	1,000
Artillerie de siége (à 6) .	120
Voit., artill. de campagne	10,080
Voit., artill. de siége .	1,772
Parc du génie . .	28
Vivres	2,838
Bâts	848
Total . .	28,686

	Voitures.
Artillerie de campagne, dont 1,900 à raison de (5,2 chevaux et 100 à 2 chevaux	2,000
Parc, artillerie de siége	443
Parc du génie	7
Vivres, dont 500 à 4 chevaux, et 418 à 2 chevaux seulement	918
Total . .	3,368

	Hommes.
Infanterie	60,000
Cavalerie	12,000
Artillerie	2,500
Génie	500
Train des équipages	1,502
Total	76,502

Récapitulation.

	Hommes.	Chevaux.	Voitures.	Canons.
Bristol	32,161	11,108	1,194	100
Plymouth	43,137	18,012	2,814	166
Rye	76,502	28,286	3,368	270
	151,800	57,806	7,376	536

"Dans le cas où l'évaluation que nous venons de faire du nombre de voitures nécessaires au transport du matériel d'artillerie et du génie, considéré comme indispensable pour le siége des fortifications de Plymouth et de Portsmouth, pourrait paraître exagérée à nos lecteurs, nous rappellerons simplement le nombre des projectiles de toute nature, et de kilogrammes de poudre qui fut consommé au siége de deux petites villes d'Espagne, en 1810, Cindad-Rodrigo et Alméïda.

"Cindad-Rodrigo avait 2 enceintes; la première consistait en une ceinture de murailles flanquées de tours, la seconde en 7 fronts bastionnés avec fossés et ouvrages avancés. La garnison était de 4,900 hommes: elle soutint 39 jours de tranchée ouverte.

"Les Français consommèrent 18,286 boulets de 24, 16, et 12,
„ „ 14,859 bombes et obus,
„ „ 60,900 kilogrammes de poudre,
„ employèrent 22,700 sacs à terre,
„ „ 600 saucissons,
„ „ 2,615 gabions.

"Alméïda avait 6 fronts bastionnés, avec demi-lunes et places d'armes saillantes et rentrantes, et 5 mille hommes de garnison: elle soutint 15 jours de siége, pendant lesquels les Français tirèrent 10 mille coups de canon avec 64 bouches à feu de gros calibre. Nous n'avons, donc, rien exagéré dans l'effectif de notre matériel.

"7°. Londres rayonne et communique par des routes de fer avec les villes ci-après de la partie est et sud-est de l'île:—

"Woolwich, Rochester, Chatam, Whitstable, Margate, Ramsgate, Deal, Sandwich, Douvres, Folkstone, Maidstone, Wells; par le South-Eastern et le Brighton Railway.

"Avec Croydon, Hastings, Eastbourne, Newhaven, et Brighton; par le Brighton Railway.

"Avec Shoreham, Arundel, Chichester, Fareham, Gosport, et Portsmouth; par le South-Coast Railway.

"Avec Guildford, Winchester, Southampton, et Dorchester; par le South-Western Railway.

"Avec Bristol, par le Great-Western Railway.

"Et avec Exeter et Plymouth, par l'Exeter et South-Devon Railway.

"Bientôt Weymouth sera relié à Londres par le Great-Western, auquel s'embranchera le Wilts-Somerset Railway à Westbury.

“Il résulte de là (à ne considérer que la partie sud-est des Iles Britanniques) qu'il n'y a pas un point de la côte, de Woolwich à Plymouth, qui ne soit mis directement en communication avec la métropole. Cherchons maintenant à quelle distance et à combien d'heures en sont les points principaux.

“De Londres à Plymouth, il y a 222 milles, qui, à raison de 1,609 mètres pour 1 mille, font 355 kilom. 19 ; et, à raison de 40 kilom. à l'heure, 8½ h.

		Distance en kilom.	Distance en heures.
“De Londres à	Exeter	285	7¼
”	Dorchester	226	5¾
”	Southampton	129	3¼
”	Gosport	144	3½
”	*Portsmouth	144	3½
”	*Chichester	128	3¼
”	*Brighton	80	2
”	*Hastings	119	3
”	Newhaven	99	2½
”	Folkestone	132	3¼
”	Douvres	141	3½
”	Deal	164	4
”	Ramsgate	156	3¾
”	Margate	162	4
”	*Chatam	36	4
”	Croydon	16	½
”	Guildford	38	1
”	*Bristol	190	4¾

“Ces villes (sauf celles marquées d'une astérisque) sont mises en communication avec la métropole par le télégraphe électrique, et il est probable que d'ici à peu de temps elles le seront toutes. Examinons maintenant, à l'aide d'un calcul scrupuleux, de quelle utilité seront à la mobilisation de l'armée anglaise les nombreuses lignes de chemins de fer dont le pays est sillonné, dans l'hypothèse que nous avons adoptée de l'invasion de l'île par trois corps d'armée séparés.

“Nous avons donné plus haut un dénombrement des forces régulières de terre et de mer, pris sur une moyenne de quelques années ; mais au point où nous sommes arrivés de notre travail, il importe de ne rien avancer à la légère ; nous avons donc dû chercher à nous procurer un état exact des forces de terre *pour l'année* 1850. Cet état, le voici :—

“*Cavalerie, Infanterie, Artillerie, et Génie.*

Angleterre et Écosse	37,843 h.
Irlande	24,005
Europe et Méditerranée	7,915
Asie	30,467
Afrique	3,703
Amérique.	
Nouvelle-Galles du Sud, Nouvelle-Zéland, Terre de Van-Diemen, île Maurice, Bermudes, Indes occidentales	19,835
Total	123,768 h.

“ A quoi il faut ajouter les corps suivants :

Enrolled pensioners	30,000 h.
Dockyard-men	8,000
Militia	4,700
Yeomanry	13,441
Total	56,141 h.

“ Ainsi donc, si nous omettons, comme cela doit être, tous les corps de l'armée régulière de terre, disséminés dans les colonies anglaises et celui qui occupe l'Irlande, et si nous y ajoutons le corps des enrolled pensioners et celui des dockyard-men, nous arriverons à un chiffre de 75,843 hommes. Mettons, à cause des hommes malades ou empêchés, 74 mille. Sur ces 74 mille hommes de l'armée mobilisable au premier appel, nous devons encore déduire les troupes casernées à Windsor, á Hyde-Parc, à la Tour de Londres, à Westminster, à Portsmouth, à Plymouth, et à Chatam, et qui ne quitteraient certainement pas ces garnisons au moment d'un danger pressant. Leur effectif est, d'après un tableau que nous avons sous les yeux, d'environ 9,568 hommes ainsi répartis :—

“ 5,260 h.	à Windsor, Hyde-Parc, Westminster, la Tour de Londres . .	Grenadier-guards, Coldstream-guards, Scotch fusileers.
1,308	*Idem.*	Life - guards, horse-guards.
3,000	Portsmouth, Gosport, Chatam. . .	Trois régiments d'infanterie de ligne.
9,568 h.		

“ Il resterait donc, après avoir fait cette déduction, une armée de 64,432 hommes, mobilisable au premier instant, et composée de soldats aguerris ; quant aux 4,700 hommes de milice et aux 13,441 hommes d'Yeomanry, nous n'en faisons mention que pour mémoire : il ne nous paraît pas possible de les classer parmi les troupes qui seraient prêtes à lutter immédiatement avec des régiments de ligne bien exercés et bien disciplinés. Cela ne se pourrait sans témérité qu'après leur avoir donné quelques mois de service sous les drapeaux pour les plier à la subordination, aux manœuvres et au dur apprentissages des fatigues de la guerre.

“ D'après l'hypothèse que nous avons admise d'un débarquement sur trois points différents, le canal de Bristol, Plymouth, et Rye, l'armée mobilisable de la Grand-Bretagne devrait aussi, au premier moment, se partager en trois corps destinés à marcher au devant de l'ennemi. Nous admettons que le centre des opérations serait Londres, comme cette capitale est aussi le nœud où aboutissent et se croisent toutes les lignes de chemins de fer qui sillonnent l'empire, c'est de là que partiraient par des convois spéciaux les trois corps d'armée que nous évaluerons chacun au tiers de l'armée disponible au premier instant, soit au tiers de 64,432 hommes ou 21,477 hommes ainsi répartis entre les trois armes, d'après les règles en usage :

Infanterie	14,173 h.	
Cavalerie	4,295	$\frac{1}{5}$ du total.
Artillerie	2,684	$\frac{1}{8}$ „
Train des équipages	325	$\frac{1}{69}$ „
	21,477 h.	

et 84 bouches à feu, ou 14 batteries de 6 pièces, à raison de 4 pièces par mille hommes.

"Calculons maintenant le nombre de trucks et de wagons nécessaires pour transporter cette armée ; évaluons le poids à déplacer, le nombre de locomotives nécessaires pour le remorquer, et le temps rigoureusement nécessaire pour le transporter de Londres au lieu de sa destination.

"1°. *Infanterie.* Un soldat d'infanterie pèse, armé et équipé, 90 kil. Un wagon de 36 places pèse, non chargé, 3,300 kil., et chargé 6,540 ; 25 wagons transporteront 906 hommes, force de 1 bataillon ordinaire, auxquels il conviendrait d'ajouter 2 wagons à marchandises et à bestiaux pour le transport du cheval du lieutenant colonel et de 4,000 kil. de bagages : ces wagons pèsent 3,600 kil., ce qui donne un total de 11,600 kil.

"Poids du convoi d'un bataillon :

25 wagons à voyageurs, à 6,540 kilogr. chaque . .	163,500 k.
2 wagons à bestiaux et bagages	11,600
Total du poids du convoi du bataillon .	175,100 k.

"Pour avoir le poids du convoi du corps de 14,173 hommes, il faudra multiplier les chiffres ci-dessus par 15, ce qui donnera :

Pour 375 wagons à voyageurs	2,452,500 k.
30 wagons à bestiaux et bagages	174,000
Plus pour 583 h. restant, 16 wagons à voyageurs supplémentaires, à 6,540 k.	104,640
Total du poids pour l'infanterie .	2,731,140 k.

"2°. *Cavalerie.*—Les chevaux sont commodément distribués par 6 dans les wagons dits à bestiaux et à marchandises, qui peuvent, en outre, recevoir 4 hommes. Un wagon à bagages peut contenir 42 selles paquetées et 4 hommes. Un wagon chargé de 6 chevaux et 4 hommes pèse 6,770 kil. Un wagon chargé de 42 selles et 4 hommes en pèse 5,376.

"Prenons l'évaluation du poids d'un escadron de 126 hommes, nous aurons, d'après les données ci-dessus :

21 wagons (portant 126 chevaux et 84 h.) . .	142,170 k.
3 wagons (portant 126 selles et 12 h.) . . .	16,168
1 wagon à voyageurs pour les 30 h. restant . .	5,880
1 truck à ponts pour débarquer en route entre les stations	8,000
Bagages des hommes transportés, évalués à . .	1,875
Total du poids du convoi d'un escadron . .	173,093 k.

"Poids du convoi portant les 4,295 chevaux et leurs cavaliers :

714 wagons, portant 4,284 chevaux et 2,856 cavaliers	4,833,780 k.
102 wagons, portant les selles et 408 h.	549,612
30 wagons à voyageurs pour 36 h. chacun, portant le reste de cavaliers	196,200
34 trucks à ponts	272,000
Bagages des hommes (1,875^{k} 34)	63,750
Total	5,915,342 k.

"3°. *Artillerie.*—En Angleterre, une batterie ou brigade est composée de 6 pièces, 5 canons et 1 obusier. (Nous ferons le calcul pour des pièces de 9 pesant et l'obusier de 5 po. ½). Voici la composition de la brigade :

DÉNOMINATIONS.	Nombre des pièces, caissons, etc.	Conducteurs.	CHEVAUX.		
			De selle.	De trait.	Totaux.
Canons de 9 pesant	5	15	„	30	30
Obusier pesant de 5 po. ½	1	3	„	6	6
Chars de munitions, canons	5	10	„	20	20
„ „ obusier	1	2	„	4	4
Affût de rechange portant roues, bourrelier, charron et outils	1	2	„	4	4
Char d'équipage de campagne	1	2	„	4	4
Chariot, forge	1	2	„	4	4
Service des officiers et sous-officiers	„	6	11	„	11
Réserve	„	8	1	7	8
Totaux	15	50	12	79	91

" Ces brigades sont servies chacune par *Artilleurs :* 1 capitaine, 1 lieutenant, 6 sous-officiers, et 60 canonniers. *Train :* 1 lieutenant, 1 sergent, 3 caporaux, 1 trompette, 1 maréchal ferrant, 1 forgeron, 1 charron, 1 bourrelier, et 50 conducteurs. En sorte que

Le personnel est de :	artilleurs	68
„	train et conducteurs	60
Le matériel est de :	voitures et pièces	15
„	chevaux	91

" En admettant une plate-forme ou truck pour 2 voitures, 2 ou 3 hommes, et quelques bagages, un wagon à bestiaux pour 6 chevaux et 4 hommes, et 2 wagons à voyageurs pour les officiers, complétés par les sous-officiers et canonniers, le matériel se composerait, pour une brigade ou batterie :

" 1°. De 8 trucks portant 15 voitures et 24 hommes ;

" 2°. De 16 wagons-écuries portant 91 chevaux et 64 hommes ;

" 3°. De 2 wagons à voyageurs, portant les officiers et les 40 hommes restant.

" Maintenant, quel serait le poids de ce convoi ?

" La pièce de 9, équipée et approvisionnée, affût et avant-train compris, pèse 1,992^{k} 52. Son caisson chargé pèse 1,319^{k} 88. L'obusier de 5 po. ½, équipé et approvisionné, affût et avant-train compris, pèse 2,084^{k} 98. Son caisson chargé pèse 1,385^{k} 61. L'affût de rechange pèse 1,772 kil. ; le chariot de parc, 1,803. Le chariot-forge pèse 1,787 kil. Nous avons vu que le wagon à voyageurs pèse 3,300 kil., le truck en pèse 9,000, et le wagon-écurie 3,600 kil.—Nous aurons donc :

a. 8 trucks portant les pièces, les voitures, et 24 hommes	75,554^{k} 59
b. 16 wagons portant 91 chevaux et 64 h.	106,221 0
c. 2 wagons à voyageurs pour les officiers, sous-officiers, et les hommes restants	11,370 0
Total du poids du convoi de la brigade	193,145^{k} 59

" Et pour 14 brigades ou batteries semblables, et 9 wagons à voyageurs portant une réserve de 332 hommes, complément des 2,684, nous aurons un poids total de 3,764,610 kil.

" *Train des Equipages.*—Nous admettons qu'il n'y a pas lieu à pourvoir à des voitures de vivres pour l'armée anglaise opérant en Angleterre, comme nous l'avons fait pour l'armée française, à raison de 12 voitures pour mille hommes ; mais, afin de ne rien négliger, nous calculerons le transport, de Londres aux points de débarquement, des hommes du train qui pourraient être appelés plus tard à suivre l'armée dans des marches sur des grandes routes, avec des convois de voitures.

" 325 hommes et 9 wagons à voyageurs forment un poids total de 58,750 kil.

" En récapitulant, nous trouverons que le poids total du convoi de l'armée dirigée de Londres sur Plymouth, Bristol, ou Ryde, sera de 12,134,092 kil., soit 12,134 tonnes de mille kilogr.

" La question qui se présente ensuite est de savoir combien il faudrait de convois et de locomotives pour effectuer le transport de ces 12 mille tonnes, et à quelle vitesse ils devront marcher.

" Posons d'abord quelques règles fondamentales :

" 1°. Les locomotives en usage actuellement peuvent remorquer, à la vitesse de 40 kilom. à l'heure, une charge de 80 tonnes ;

" 2°. Elles peuvent en remorquer 140, à une vitesse modérée de 20 à 25 kilom. ;

" 3°. Une locomotive en bon état ne peut remorquer un train plus loin que la distance de 300 kilom. ;

" 4°. Avec 2 locomotives à la suite l'une de l'autre, on peut doubler un convoi.

" Il résulte de ces principes qu'il faudrait, pour transporter les 12 mille tonnes de Londres à une distance de 300 kilom. : 152 convois de 80 tonnes, marchant avec une vitesse de 40 kilom. à l'heure, ou 97 convois de 140 tonnes, marchant à 20 ou 25 kilom. par heure. Et, si on double les convois : 76 convois de 80 tonnes, remorqués par 152 locomotives, ou 49 convois de 140 tonnes, remorqués par 97 locomotives ; Plymouth étant à 335 kilom. de Londres, il faudra pour 4 convois de cette direction un nombre double de locomotives, soit 304 marchant à 40 kilom., ou 194 marchant à 20 ou 25 kilom., d'où il résulte que nous pouvons établir le tableau suivant :—

" TRANSPORT DES TROIS CORPS D'ARMÉE ANGLAIS.

DISTANCES.		Nombre de convois de 80 tonnes.	Nombre de locomotives.	Convois doublés.	Nombre de locomotives.	Nombre de convois de 140 tonnes.	Nombre de locomotives.	Convois doublés.	Nombre de locomotives.
De Londres	à Plymouth...	152	304	76	304	86	172	43	172
	à Rye	152	152	76	152	86	86	43	86
	à Bristol	152	152	76	152	86	86	43	86
	Totaux	456	608	228	608	258	344	129	344

" Passons maintenant au calcul du temps qui devra s'écouler entre le moment où tous les convois seront prêts à partir, et le moment de leur arrivée au lieu de leur destination. L'intervalle entre le départ de chaque convoi ne peut être au-dessous de 30 minutes, à cause des temps d'arrêts indispensables pour prendre de l'eau, du charbon, et pour franchir les gares à une seule voie. Pour 152 convois il faudra donc 76 heures.

" Donc, entre le moment où les convois partiront de Londres pour Plymouth, qui en est distant de 355 kilom., avec une vitesse de 40 kilom. à l'heure, et celui où ils arriveront, il s'écoulera, en minimum, 88 heures ½.

" De Londres à Hastings (distance 3 heures), il s'écoulera 79 heures.

" De Londres à Bristol (distance 4 heures ¾), il s'écoulera 80 heures ¾.

Admettons que le télégraphe électrique ait donné à Londres le signal de l'approche de la flotte de débarquement, dès qu'elle aura été signalée au large, il faut que la capitale, à son tour, donne le signal de la concentration autour d'elle à toutes les garnisons éparses en Angleterre et en Écosse. Nous avons pris 10 de ces lieux de garnison, dont la distance moyenne à Londres est de 251 kilom., soit 6 heures $\frac{1}{4}$, à raison de 40 kilom. à l'heure. Il faut bien donner au moins un jour pour rassembler et embarquer les troupes et disposer les convois. Maintenant, le transbordement des troupes des gares d'arrivée aux gares de départ, et la répartition des bataillons dans chacun des 3 corps d'armée de défense, prendra bien encore au moins un jour. Cela fait, par conséquent, 30 heures $\frac{1}{4}$ à ajouter aux 3 sommes de temps précédemment indiquées. Nous aurons ainsi :

Temps écoulé entre le signal donné de Plymouth à Londres, et l'arrivée de l'armée de secours .	108$^{h\cdot}$ $\frac{3}{4}$	(10 jours.)
Temps écoulé entre le signal donné d'Hastings et l'arrivée de l'armée de secours . . .	109$^{h\cdot}$ $\frac{1}{4}$	(9 jours.)
Temps écoulé entre le signal donné de Bristol et l'arrivée de l'armée de secours . .	111$^{h\cdot}$	(9 jours.)

" Nous verrons plus loin qu'un corps d'avant-garde aurait le temps de débarquer sur la côte avant que l'armée de secours ne fût arrivée, il pourrait donc aussi couper en plusieurs points les rails des voies ferrées, ou préparer tout à loisir une embuscade d'où quelques pièces de canon pourront jouer sur le premier convoi qui paraîtra, briser les locomotives, et faire prisonnières les troupes contenues dans les wagons. Si l'attaque de Plymouth, par example, est précédée par une action navale et un bombardement qui occupe la garnison, le débarquement d'une partie de l'armée pourra avoir lieu sans être inquiété ; car, tout en rendant une haute justice à la bravoure et au patriotisme du peuple anglais, on nous accordera (et les écrivains militaires nationaux eux-mêmes ne le nient pas) que la population des campagnes a peu d'aptitude pour le métier des armes, pour s'enrégimenter, et peu de chance pour affronter seule avec succès une troupe aguerrie.

" Enfin, on trouvera peut-être que le résultat auquel nous arrivons est bien loin de celui announcé dans les documents anglais, où l'on parlait ' d'envoyer en 12 heures 30 mille hommes à la côte,' par les chemins de fer ! Nous en convenons, mais c'est que tout simplement notre résultat est basé sur des calculs exacts, et que le premier était un résultat approximatif indiqué un peu à la légère, en ne tenant compte ni du poids des troupes, ni de celui des voitures, trucks, &c., ni du temps nécessaire pour mettre en mouvement une série de convois.

" 8°. Nour abordons maintenant une question d'autant plus difficile qu'elle est plus nouvelle ; nous voudrions pouvoir en écarter tout ce qui est du domaine des conjectures pour ne baser notre argumentation que sur des données d'expérience ; mais malheureusement ces données manquent sur quelques points, et il faut y suppléer par des interpolations. Les lacunes que nous n'avons pas pu remplir se rapportent au maximum de capacité d'emménagement à bord des bâtiments de guerre à voile et à vapeur, quand il ne s'agit que d'une courte traversée. Toutefois, nous avons réussi à obtenir comme certaines les données suivantes :—

	Classe du vaisseau.	Hommes avec armes et bagages.
Voiles.		
Un vaisseau de ligne peut recevoir à son bord, en dehors de son équipage	120 canons	800
Id.	de 100 à 90	700
Id.	de 90 à 74	600
Une frégate	de 60	500
Id.	60 à 40	400 à 350
Une corvette de 1^{re} classe . .	...	250
Id. de 2^{e} classe . .	...	60 à 50
Vapeurs.		
Une frégate de 640 à 450 chevaux .	...	1,400 à 1,200
Et pour une courte traversée .	...	2,000
Une corvette de 320 à 220 chevaux .	...	600 à 400
Un aviso de 180 à 160 chevaux .	...	300

" Une frégate de 640 à 450 chevaux peut embarquer 900 hommes avec leurs bagages, et 100 chevaux équipés.

" Une corvette de 320 à 220 chevaux peut embarquer 300 hommes avec armes et bagages, et 70 à 60 chevaux équipés.

" Un aviso de 180 á 160 chevaux peut embarquer 100 hommes avec armes et bagages, et 20 chevaux équipés.

" Une frégate à vapeur peut remorquer à une petite vitesse 2 vaisseaux de ligne de 100 à 90 canons, et un navire de 800 tonneaux à une vitesse ordinaire.

" Un vapeur de commerce, convenablement disposé pour l'installation, pourrait embarquer pour une courte traversée 76 chevaux et leurs cavaliers.

" Un bâtiment de commerce de 800 à 500 tonneaux pourrait, avec les installations convenables, recevoir 60 chevaux et 10 voitures pour une courte traversée.

" Enfin, des documents puisés à une source authentique nons ont appris qu'en 1849,

6 frégates à vapeur de 450 chevaux,
2 corvettes *id.* 220 „
1 corvette *id.* 160 „
Et 2 transports remorqués,

ont suffi pour embarquer à Toulon, transporter à Civita Vecchia, et y débarquer 2 brigades (10,000 hommes) environ avec tout leur matériel, et cela en 10 jours, après l'ordre transmis de Paris par le télégraphe.

" En 1830, lors de l'expédition d'Alger, il s'agissait de pourvoir au transport de 1,876 officiers, 35,631 sous-officiers et soldats, de 4,512 chevaux, et de 180 bouches à feu de siége et de campagne[1]. La flotte jugée nécessaire pour cette vaste entreprise fut composée de 100 bâtiments de guerre, dont 7 à vapeur, et de 602 transports de toute espèce.

" Voici quelle était en détail la composition de la flotte réunie à Toulon :

" 11 vaisseaux de ligne, 23 frégates, 7 corvettes de guerre, 26 bricks, 29 corvettes de charge, gabares ou bombardes, 7 bâtiments à vapeur ; total : 100 navires de guerre montés par 27 mille marins ;

" 377 transports, 140 bateaux catalans, 55 chalands, 30 bateaux plats ou radeaux ; total : 602 navires de transport, etc.

" Si maintenant le lecteur reporte les yeux sur le tableau de l'effectif de l'armée d'invasion, avant de les jeter sur le tableau ci-dessous, il verra que, d'après les données indiquées précédemment, la flotte française actuelle suffirait pour embarquer cette armée avec tout son matériel.

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[1] L'effectif était :—

	Officiers.	Sous-officiers et soldats.	Chevaux.	Canons.
État-major général et employés	569	8	577	„
„ des divisions .	54	„	159	„
„ de l'artillerie .	27	14	49	„
„ du génie . .	7	7	35	„
Gendarmerie . . .	24	120	36	„
Troupes d'infanterie . .	1,010	29,772	326	„
„ de cavalerie . .	33	501	503	„
„ d'artillerie . .	73	2,254	1,309	180
„ du génie . .	38	1,272	133	„
Ouvriers d'administration .	15	813	10	„
Train des équipages . .	26	825	1,330	„
Postes et trésor . . .	„	45	45	„
	1,876	35,631	4,512	180
Total du personnel . .	37,507		4,512	180

“TABLEAU DE LA CONTENANCE DES BATIMENTS A VOILE ET A VAPEUR.

DÉNOMINATION DES BATIMENTS.		Hommes avec armes et bagages.	Canons ([1]) de camp (*c*) ou de siége (*s*).	Chevaux ([2]) de cavalerie ou de trait (*c*) (*t*).	Voitures.
GUERRE.					
Bâtiments à voile …………	24 vaisseaux de ligne …………	(700) 16,800	(6)^c 144	„	„
„	38 frégates …………	(450) 17,100	(4)^c 152	„	„
„	30 corvettes …………	(160) 4,800	(1)^c 30	„	„
„	44 bricks …………	(180) 7,920	(2)^c 88	„	„
„	38 transports …………	(150) 5,700	„	„	„
„	50 cutters, sloops …………	(100) 5,000	„	„	„
Bâtiments mixtes …………	1 frégate (de 40 canons) ……	(600) 600	(40)^s 40	„	„
„	2 corvettes …………	(250) 500	(23)^s 46	„	„
„	1 sloop …………	(100) 100	„	„	„
Bâtiments à vapeur …………	21 frégates …………	(2,000) 42,000	„	„	„
„	1 vaisseau de 960 chevaux……	(2,000) 2,000	„	„	„
„	2 corvettes 1re classe…………	(600) 1,200	„	„	„
„	20 corvettes 2^e classe …………	(400) 8,000	(2)^c 36	„	„
„	34 avisos 1re classe…………	(300) 10,200	„	„	„
„	19 avisos 2^e classe …………	(300) 5,700	„	„	„
COMMERCE.					
Bâtiments à vapeur …………	291…………	(79) 23,000	„	(76)^c 22,000	„
Bâtiments à voile …………	362…………	„	„	(60)^t 21,572	(10) 3,646
„	4…………	(300) 1,180	„	„	„
Totaux…………	982	151,800	536	43,572	3,646

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[1] La lettre *c*, en haut du chiffre entre parenthèses, désigne les pièces de campagne; la lettre *s* celles de siége.

[2] La lettre *c*, en haut du chiffre entre parenthèses, designe les chevaux de cavalerie; la lettre *t* ceux de trait

“ Ainsi, 982 bâtiments de toute sorte, dont 357 pris dans le commerce, à vapeur ou à voile, et du plus fort tonnage possible, suffiraient pour transporter le personnel et le matériel de l'armée tels qu'ils résultent des tableaux que nous avons donnés précédemment. Ce resultat, rapproché de l'effectif de la flotte qui servit pour l'expédition d'Alger, peut surprendre, au premier coup d'œil ; mais on observera que cette différence est due à la grande supériorité de contenance des bâtiments à vapeur sur les bâtiments à voile, à cause de leur moindre équipage et de leur moindre armement. En 1830, on ne se servit que de 7 vapeurs ; ici, d'après notre calcul, on en employerait près de 400, dont 100 vapeurs de guerre.

“ Occupons-nous maintenant de la répartition de l'effectif particulier aux 3 corps d'armée destinés à Bristol, à Plymouth, et à Rye, avec le matériel affecté à chacun, en ayant soin de proportionner les forces navales de chaque escadre à la longueur de leur traversée, au but qu'elles auraient à remplir, et aux circonstances qui, selon toute apparence, accompagneront leur débarquement.

“ TABLEAU No. 1.—ESCADRE DE L'AVON OU BRISTOL (BREST).

DÉNOMINATIONS.	Infanterie.	Cavalerie.	Artillerie, Génie, Train.	Chevaux, Cavalerie.	Chevaux de trait.	Canons.	Voitures.
4 vaisseaux de ligne.........	500	„	2,161	„	„	24^{c}	„
10 frégates à voile	4,500	„	„	„	„	40^{c}	„
6 frégates à vapeur	12,000	„	„	„	„	„	„
20 corvettes à vapeur, 2^{e} cl..	8,000	„	„	„	„	36^{c}	„
66 vapeurs commerce.........	„	5,000	„	5,000	„	„	„
78 bâtiments de commerce (transports)...............	„	„	„	„	4,560	„	807
184	25,000	5,000	2,161	5,000	4,560	100^{c}	807

“ Cette escadre, destinée à faire route de Brest à l'embouchure de l'Avon, qui en est éloigné de 433 kilom. environ, est composée de 40 bâtiments de guerre et 144 transports. Sur les 40 navires de guerre il y en a 26 à vapeur, dont 14 pourront donner la remorque aux 14 vaisseaux ou frégates, en cas de ventes contraires ou de calmes, et les 12 autres escorter les transports. Supposons les vaisseaux de 90 canons, les frégates de 40, et les corvettes de 20 seulement, on verra que, tout en étant mobile, elle est de force à lutter avec des forces imposantes, si elle rencontre une flotte ennemie dans le canal de Bristol.

“ L'escadre compris dans le Tableau No. 2, étant destinée à une courte traversée (260 kilom.), et surtout à attaquer un port militaire défendu par des fortifications et probablement par une flotte, nous la supposerons composée de forts bâtiments, c'est-à-dire, que les vaisseaux de ligne seront, en général, de 100 canons, et les frégates à voile de 60 ou 50. Néanmoins on verra que les bâtiments de guerre à voiles sont au nombre de 29, et ceux à vapeur au nombre de 30, de manière à ce que ceux-ci puissent toujours prêter aux autres un utile appui. Cette escadre porte environ 2,200 bouches à feu, sans compter les pièces destinées à être débarquées ; elle peut donc facilement protéger un convoi de 151 bâtiments de transport, combattre une escadre dans les eaux de la Manche et bombarder Plymouth pendant que les frégates à vapeur débarqueront de l'infanterie et de l'artillerie pour ouvrir la tranchée du côté de terre contre les fortifications de la ville.

TABLEAU No. 2.—ESCADRE DE PLYMOUTH (BREST).

DÉNOMINATIONS.	Infanterie.	Cavalerie.	Artillerie Génie, Train.	Chevaux de cavalerie.	Chevaux de trait.	Canons.	Voitures.
10 vaisseaux de ligne.........	7,000	„	„	„	„	60^c	„
19 frégates à voile	8,550	„	„	„	„	40^c	„
8 frégates à vapeur	9,450	„	6,550	„	„	„	„
1 frégate mixte...............	„	„	600	„	„	40^c	„
1 corvette mixte	„	„	250	„	„	26^c	„
1 sloop *id.*	„	„	200	„	„	„	„
19 avisos à vapeur............	„	„	5,537	„	„	„	„
66 vapeurs commerce.........	„	5,000	„	5,000	„	„	„
85 bâtiments à voile, *id.* ...	„	„	„	„	5,084	„	832
210	25,000	5,000	13,137	5,000	5,084	166^c	832

TABLEAU No. 3.—ESCADRE DE RYE (CHERBOURG).

DÉNOMINATIONS.	Infanterie.	Cavalerie.	Artillerie, Genie, Train.	Chevaux de cavalerie.	Chevaux de trait.	Canons.	Voitures.
10 vaisseaux de ligne	6,000	„	1,000	„	„	60^c	„
9 frégates à voile ...	3,050	„	1,000	„	„	36^c	„
30 corvettes *id.*	4,800	„	„	„	„	66^c	„
44 bricks *id.*	7,920	„	„	„	„	88^c	„
38 transports *id.* ...	5,700	„	„	„	„	„	„
50 cutters, sloops *id.*	5,000	„	„	„	„	„	„
7 frégates à vapeur.	12,830	„	„	„	„	„	„
1 vaisseau *id.*	2,000	„	„	„	„	„	„
2 corvettes, 1re cl. *id.*	(700) 1,400	„	„	„	„	20^s	„
34 avisos *id.*	(400) 11,300	„	2,300	„	„	„	„
1 corvette mixte ...	(250) „	„	202	„	„	„	„
159 vapeurs de commerce	„	12,000	„	12,000	„	„	„
199 bâtiments à voile de commerce ...	„	„	„	„	11,928	„	2,007
584	60,000	12,000	4,502	12,000	11,928	270	2,007

" L'escadre de Rye est la plus forte des 3 : dans son trajet assez court, il est vrai, du port de Cherbourg aux côtes de Kent, elle peut rencontrer l'escadre du (home service), qui était, en 1845, de 6 vaisseaux et de 6 frégates, sans compter les steamers de guerre ; il importerait donc de la partager en plusieurs divisions ; mais il n'est pas de notre compétence d'entrer dans des détails aussi techniques. Toutefois, il nous semble que, pour éclairer la marche de cette grande flotte de plus de 580 bâtiments, dont 224 navires de guerre, il pourrait être convenable de former une division composée de 1 ou 2 frégates à vapeur et de 15 à 20 avisos, qui jetteraient sur les côtes 6 ou 8,000 hommes pour préparer l'opération du débarquement de cette puissante armée. Il resterait alors, pour le protéger, 11 vaisseaux, 15 frégates, et 3 grandes corvettes, c'est-à-dire, plus de 1,500 bouches à feu, sans compter les bricks et les corvettes à voile, qui en représentent plus de 1,300.

" Nous venons de voir que le port de Brest devrait pouvoir réunir 394 bâtiments, dont 99 grands navires de guerre, soit à voile, soit à vapeur, soit mixtes, et celui de Cherbourg 584, dont 226 bâtiments de guerre. Ces deux vastes ports sont dans les meilleures conditions possibles pour protéger ces armements, il n'y a donc là aucune difficulté matérielle. Il ne paraît pas en exister de plus graves à concentrer, 60,000 hommes d'infanterie sur Cherbourg et 50,000 sur Brest, sauf la perte de temps résultant des dernières étapes qu'il faudra faire effectuer à pied à la troupe, faute de chemins de fer aboutissant à ces deux villes. Et c'est peut-être ici le cas de déplorer la lenteur inconcevable avec laquelle des lignes si utiles (puisqu'elles mettaient en communication deux des principaux ports de France avec le métropole) ont été poussées jusqu'à ce jour !

" Il est bien évident que les corps qui feraient partie de l'armée expéditionnaire seraient pris dans les garnisons les plus rapprochées de ces deux ports, ou par leur situation topographique, ou par les routes de fer. Ainsi, pour le *génie,* ce seraient les villes d'Arras et de Metz qui fourniraient les troupes et le parc. Toutes deux communiquent avec Paris par des chemins de fer. De Paris, le détachement destiné aux escadres de l'Avon et de Plymouth prendra le chemin de fer de Nantes, et de Nantes on le dirigera sur Brest par mer ou par étapes de 28 kilom. Le détachement destiné à l'escadre de Rye prendra le chemin de fer de Paris à Évreux, et de là marchera par étapes sur Cherbourg ; les garnisons de Strasbourg, Metz, Rennes, et Douai, fourniront l'*artillerie :* des convois spéciaux amèneront les troupes et les parcs de Strasbourg, de Metz, et de Douai ; et le régiment de Rennes sera acheminé sur Brest par étapes. Les *équipages militaires* viendront de Laon, de Vernon, et de Paris. La *cavalerie* sera prise dans les garnisons du Mans, de Poitiers, de Paris, de Chartres, de Limoges, Niort, Nantes, Châteaudun, pour *Brest ;* dans celles de Cambrai, Valenciennes, Meaux, Versailles, Fontainebleau, Saint-Germain, Melun, Lille, Arras, Provins, Tours, Verdun, Rambouillet, Compiègne, Abbeville, et Vendôme, pour *Cherbourg.*

" L'*infanterie* destinée à s'embarquer á Brest (50,000 hommes) se recrutera dans les garnisons de Saint-Brieuc, Lorient, Angoulême, Nantes, Napoléon-Vendée, Rennes, Vannes, La Rochelle, Laval, Paris, etc.

" Celle destinée à Cherbourg (60,000 hommes) se recrutera dans les garnisons de Versailles, Arras, le Havre, Caen, Douai, Amiens, Dieppe, Dunkerque, Blois, Valenciennes, Laon, Orléans, Lille, Évreux, Verdun, Soissons, Troyes, Paris, et Cherbourg.

" Les chemins de fer de Strasbourg, du Nord, de Dieppe, du Havre, de Rouen, de Chartres, de Nantes, et de Lyon, serviront en partie au transport du personnel et du matériel de cette nombreuse armée ; malheureusement, ainsi que nous l'avons déjà observé, les dernières étapes devront se faire à pied, puisqu'aucune ligne n'aboutit encore ni à Brest ni à Cherbourg.

" Serait-il bien difficile de réunir d'avance à Cherbourg et à Brest les bâtiments de guerre et les transports nécessaires à l'expédition ? Nous pensons, nous, que, si la guerre n'a pas été prématurément déclarée, il sera facile au gouvernement de diriger sans bruit, de Toulon et de Rochefort, sur Cherbourg et sur Brest, des navires à voile et des vapeurs de guerre. Quant aux transports, ils pourront se réunir d'abord par groupes à Calais, Boulogne, Dieppe, le Havre, et gagner de là les deux ports militaires pour y recevoir leur chargement ; mais ces préparatifs devront se faire prudemment, pour ne pas donner à l'Angleterre de prétexte pour leur courir sus avant la déclaration de guerre.

" Maintenant, il peut être curieux de se demander combien de temps pourrait prendre l'embarquement des troupes et du materiel. Pour répondre à cette question, il est nécessaire de se reporter aux précédents. En 1830, l'embarquement de 37,500 hommes pour l'expédition d'Alger prit 3 jours ; d'aprés cette donnée, celle des 2 escadres destinées à l'embouchure de l'Avon et à Plymouth en prendrait 6, et celui de l'escadre de Rye 6 également. En 1830, il s'écoula 55 jours entre la proclamation insérée au *Moniteur* le 20 avril, et la première dépêche datée de Torre-Chica, le 14 juin. Il est certain que si jamais la France se décidait à tenter l'invasion de l'Angleterre, entre le moment de l'embarquement des troupes et celui de leur arrivée de l'autre côté du canal, le temps serait beaucoup plus court. Nous ne compterons pas le temps nécessaire à la concentration des troupes et du matériel et celui de la réunion des flottes, car tant que ces préparatifs se feraient en secret, l'Angleterre ne devrait pas prendre d'ombrage ; admettons, sans sortir pour cela du domaine des probabilités, que le secret ne soit trahi que dès que les corps se prépareront à l'embarquement, le même jour il sera porté de l'autre côté du détroit avec la déclaration de guerre ; de Brest à l'embouchure de l'Avon, il y à 34 heures pour une flotte qui peut être remorquée par de puissants steamers, et 17 heures jusqu'à l'entrée du Sound. En conséquence, 7 jours et 10 heures après l'ordre envoyé de Paris pour embarquer, l'escadre française No. 1 serait à l'embouchure de l'Avon ; 6 jours ½ après, l'escadre No. 2 serait devant Plymouth. De Cherbourg à Rye, il y a 14 heures. L'escadre No. 3 mettrait donc à peu près le même temps que la précédente à embarquer et transporter son corps d'armée devant les côtes de Kent."

. . . .

" Si le lecteur prend la peine de relire l'opinion des hommes de guerre anglais qui avaient mission pour se prononcer sur cette importante question, il sera forcé de convenir qu'à part l'augmentation de l'effectif de l'armée de terre, il n'y avait pas grande uniformité dans les conseils donnés au gouvernement. Il est vrai que la question n'est pas simple. Pour être résolue d'une manière convenable, il importe de poser d'abord certains principes fondamentaux.

" A. La défense d'un pays quelconque repose principalement sur trois choses : 1°, ses places fortes ; 2°, ses armées de terre (et de mer, si elle a des frontières maritimes) ; 3°, ses moyens accessoires de défense, tels que les montagnes, les parties de pays inabordables aux convois et à l'artillerie, et dans un sens inverse, les canaux, les chemins de fer, et les lignes de télégraphe électrique, comme facilitant la circulation du dedans au dehors, les concentrations de troupes, et les manœuvres sur les flancs de l'ennemi.

" B. Si le pays attaqué n'est pas, comme la Suisse, l'Italie, ou la Hollande, un pays décentralisé, s'il est comme la France ou l'Angleterre, qui vivent de la vie de leur métropole, il importe que cette métropole ne soit pas exposée à être enlevée par un hardi coup de main de l'ennemi, à la suite d'une bataille gagnée. Napoléon le dit, dans le volume ix. de ses *Mémoires :* 'Si, en 1805, Vienne eût été fortifiée, la bataille d'Ulm n'eût pas décidé de l'issue de la guerre, le corps d'armée que commandait Kutusow y aurait attendu les autres corps de l'armée russe déjà arrivés à Olmütz et l'armée du Prince Charles, arrivant d'Italie.

" 'Si Berlin avait été fortifiée en 1806, l'armée battue à Jéna s'y fût ralliée, et l'armée russe l'y eût rejointe.

" Si, en 1808, Madrid avait été une place forte, l'armée française, après les victoires d'Espinosa, de Tudella, de Burgos, et de Sommosierra, n'eût pas marché sur cette capitale en laissant derrière Salamanque et Valladolid l'armée anglaise du Général Moore et l'armée espagnole de la Romana; ces deux armées anglo-espagnoles se fussent réunies sous les fortifications de Madrid à l'armée d'Aragon et de Valence.

" 'Si Paris eût été une place forte, en 1814 et 1815, capable de résister seulement huit jours, quelle influence cela n'aurait-il pas eue sur les événements du monde?'

" Enfin, en parlant de l'occupation de Londres par les Français, nous avons vu un journal anglais (voyez p. 108), déclarer que, 'Maître de Londres, l'ennemi pourrait imposer au pays les conditions les plus ignominieuses.'

" Ces principes une fois posés, examinons quel serait le meilleur plan de défense nationale à adopter pour l'Angleterre:

. . . .

" Conviendrait-il de créer un grand nombre de places sur le littoral, indépendamment des ports fortifiés et des ouvrages défensifs qui existent déjà?

" On voit donc bien que si le peuple anglais se résignait à voir fortifier sa capitale, non-seulement l'opération matérielle ne serait pas impraticable, avec des sacrifices et un peu de patriotisme de la part des habitants des faubourgs, mais encore qu'elle serait la meilleure sauvegarde du pays.

" Comme d'ailleurs, ainsi que nous l'avons dit, nous ne pensons point que jamais l'opinion publique se laisse forcer la main jusqu'à consentir à voir Londres devenir une place de guerre, nous allons chercher quel serait le meilleur plan à adopter, à défaut de celui-là, pour résister à une invasion étrangère.

" Évidemment ce sont de grands camps retranchés, placés assez loin de la capitale, pour qu'à la suite d'une action heureuse pour ses armes l'ennemi ne l'occupe pas du même coup, et reliés entre eux par des chemins de fer de ceinture, qui permettront aux troupes de se porter rapidement sur le point menacé. Ces camps devraient, en outre, être en communication habituelle avec la métropole par des lignes de fer aboutissant directement sur leurs derrières.

" Nous ne fixerons pas les emplacements de ces camps; il faudrait avoir des accidents de terrain que présente la contrée à 10 milles de Londres environ[1] une connaissance que nous ne possédons pas; mais nous pensons que les indications du Colonel Lewis devraient être suivies: il indique Shooter's-Hill, Croydon, Kingston, Windsor, Marlow, et Hygh-Wycombe. Voilà pour le sud-est; mais il faudrait compléter la ceinture au nord et à l'est.

" Il est clair que le choix de ses emplacements devra dépendre de plusieurs sortes de considérations:

" 1°. De leurs avantages stratégiques.

" 2°. De leur proximité des villes, villages, propriétés particulières, proximité tantôt à éviter, tantôt à rechercher.

" 3°. De la direction des chemins de fer qui les traversent, de celle des cours d'eau, canaux, routes, qui se trouveront à leur portée.

" Nous conseillerions pour les camps retranchés l'emploi de la fortification mixte, c'est-à-dire, l'établissement en temps de paix d'ouvrages à escarpes revêtues en briques et à talus intérieurs également revêtus, pour empêcher les injures du temps et les dégradations que déformeraient par trop leurs profils. Pour couvrir le camp, nous donnerions la préférence aux *lignes bastionnées et à batteries détachées*, parce que ces lignes réunissent les avantages propres aux lignes continues, et à celles à intervalles; elles permettent une défense active et des retours offensifs. L'infanterie est à couvert, l'artillerie balaye le terrain en avant, et la cavalerie peut charger par les intervalles. Les trois armes se prêtent ainsi un mutuel appui.

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[1] Tous les militaires comprendront pourquoi nous avons placé ces points stratégiques de défense aussi près du point objectif de l'ennemi. C'est pour qu'il ne puisse pas, en manœuvrant pour éviter ces points stratégiques, gagner, avant le défenseur, sa ligne d'opération défensive, et lui couper sa retraite sur Londres.

. . . .

" Ainsi que nous l'avons dit précédemment, nous n'essayerons pas d'évaluer exactement la dépense de ce camp retranché; mais nous doutons fort qu'il s'élevât au quart de la somme de 10 millions de francs, dont parle M. le Colonel Lewis, pour un camp de 25 mille hommes, avec des escarpes de 4 mètres de hauteur, et seulement en bonne maçonnerie; des talus intérieurs maçonnés en briques, et des contrescarpes non revêtues, il nous semble que la construction des six fronts serait exécutable pour 2 millions et demi de francs. Celle des baraques (en prenant les prix de France) monterait environ à la somme de 396,760 fr. pour un seul camp.

" Six ou sept camps retranchés placés autour de Londres, à 10 ou 15 milles de distance de la ville, appuyés à des rivières ou placés sur des hauteurs, donneraient à une armée de 60,000 hommes, et surtout de 60,000 Anglais, le double de sa valeur réelle, en lui permettant de livrer des batailles défensives, genre d'action auquel le calme et la fermeté naturelle au caractère national la rendent éminemment propre. En outre, ce système de défense, s'il était adopté, et si les ouvrages qu'il nécessite étaient exécutés peu à peu, n entraînerait pas le pays dans des dépenses incompatibles avec le développement des grandes entreprises commerciales et industrielles auxquelles il aime à se livrer.

" Il résulte de ce Mémoire sur la défense nationale en Angleterre trois conséquences capitales :—

" 1°. Les chemins de fer anglais ne peuvent contribuer *que dans une certaine mesure* à la défense du pays, et il serait imprudent de croire qu'ils forment la *seule* sauvegarde, comme on l'a avancé.

" 2°. Quel que soit le mode de fortification qu'on adopte, forts détachés, enceinte continue, ou camps retranchés, il faut nécessairement couvrir la métropole, et abandonner l'idée de créer de nouvelles citadelles sur le littoral.

" 3°. Le personnel de l'armée de terre active doit être nécessairement augmenté, quel que soit le système de défense adopté, et cela plus tôt que plus tard, parce que la flotte ne pourra jamais à elle seule empêcher un débarquement sur les côtes d'Angleterre.

" Le travail que nous livrons à l'appréciation des hommes politiques et des hommes de guerre de la Grande-Bretagne sera lu, nous l'espérons du moins, avec la persuasion qu'il a été dicté par un sentiment de complète impartialité. Et comment pourrait-il en être autre autrement? L'auteur n'appartient-il pas à un pays dont la destinée et le devoir sont de rester toujours neutre au milieu des conflits de ses puissants voisins. On pourrait se demander s'il y a opportunité dans cette publication. Les événements dont depuis deux ans l'Europe est le théâtre, et la politique adoptée par M. le ministre des affaires étrangères en Angleterre, répondront pour nous. S'il est permis d'espérer que la paix ne sera pas troublée, et que les grands gouvernements de l'Europe continueront à vivre en bonne harmonie les uns avec les autres, afin de mieux réprimer chez eux les écarts désordonnés de l'esprit révolutionnaire, qui peut prévoir les perturbations que l'Égypte et Constantinople peuvent apporter un jour dans l'équilibre européen?

" L'Angleterre a raison d'avoir foi dans son étoile et dans la suprématie maritime que de longues luttes lui ont acquise; mais il serait sage à elle de ne pas en conclure qu'elle est invulnérable. La navigation à vapeur, les chemins de fer, et le télégraphe électrique, ajoutent puissamment à ses ressources de défense; mais ils facilitent aussi les moyens d'attaque, et aplanissent les routes qui conduisent à ses rivages. L'Angleterre a démesurément étendu ses enterprises commerciales et industrielles, en comptant sur un long avenir de paix. Voici trente-cinq ans que cette paix dure; si la guerre éclatait tout d'un

coup, serait-elle prête à la soutenir? Telle a été la pensée qui a ému quelques-uns des hommes éminents de la Grande-Bretagne, et qui leur a mis la plume à la main[1].

"Telle est aussi l'importante question qu'il nous a paru intéressant de traiter à un point de vue purement special et scientifique. Nous souhaitons de n'être pas resté trop au-dessous de la tâche que nous avions entreprise."

There are two points to which it is not easy to put a negative to M. Maurice. First, the probability of an armament reaching the English coast undisturbed, and that the facilities of defence afforded by railways are very much exaggerated, and their value overrated in conveying infantry, artillery, and cavalry, to the points of debarkation. All that can be depended upon in the first instance is, that our navy should prevent a second attempt and the arrival of reinforcements; and in the second case, that the resources of the railway establishments should be devoted to the transport of troops and their supplies under the control of the Quarter Master General's department.

We must, therefore, in considering any system of defence, concede the possibility of an armament reaching our shores, and consider the means of repelling a hostile force on the spot, and view the railway only as the support to the troops actually engaged.

These considerations have engaged the attention of the compiler of this paper in his former speculations on this subject, and his propositions of defence are based upon them. Having in view, likewise, the improbability of any debarkation of an army occurring to the westward of Hampshire, these propositions were—*

1. That it was necessary, on the first rupture with France, to have stationed on the coasts a certain force, distributed in localities calculated to meet any attempts to debark an army on our southern shores.

2. In the event of this precaution failing, that we should have other resources; 1st, by a few places well fortified, parallel with, and at some distance from, the southern shore of England; and 2ndly, by a range of entrenched camps in the vicinity of London.

To carry out the first suggestion of defence, it was deemed desirable, during peace, to construct barracks at certain localities, close to the coast line, and that they should form permanent posts, provided with every requisite for stores and provisions, and ready means to convey their garrisons to the points threatened by the railways, which now run parallel with the coast—the garrisons being about 2000 men, each composed of two or three battalions of infantry, two squadrons of cavalry, and two batteries of artillery. That if the precautions were not taken during peace of establishing these posts, it would be too late at the breaking out of a war, as it would only be at the commencement of hostilities that an enemy would have any chance of success. Hence it is that military men urge the public to consider the necessity of such defences as are required being constructed before they are wanted.

Recapitulating the former suggestions, in the probable order of their being brought into play, supposing a fleet hovering along the accessible points of our southern coasts in force, we have considered that the only mode of meeting an enemy in their attempt to land can be, by having a moveable force in railway

[1] *Agitation on National Defence.* Defenceless State of Great Britain.

* See map of southern coast of England.—Ed.

waggons parallel with the hostile fleet; and when it anchors * the train will halt, and the troops move to the shore; the infantry will place themselves under cover of the beach, or epaulements thrown up by them at the moment, to obtain security from a cannonade which will precede their attempts to land. The field battalions will take up such positions as will best see the approach to the shore, and afford protection to themselves; and the cavalry take advantage of some natural cover near the threatened point, dismount, and wait until the enemy's boats touch the shore. This is the period for cavalry to act, to dispute the landing, charging with vigour the troops scrambling out of the boats, unformed, and necessarily in great confusion; the field-guns having previously kept a constant fire on the boats from 1200 yards distance, with round, shrapnel, and case shot, for a period at least of a quarter of an hour, and the infantry, musketry, &c., for five minutes.

In resisting an embarkation, the important point is never to allow the troops to form when they jump on shore; but, by repeated attacks of cavalry, and charges of infantry, keep the enemy in confusion (until he is destroyed or surrenders), which a well-judged application of artillery and musketry fire will contribute materially to effect.

Indeed, it may be considered as an axiom, that no landing could be successfully effected in the presence of 2000 men well prepared, as explained above.

But to accomplish this, it has been suggested as necessary that certain localities should be occupied, such as

Ashford,
Battle,
Lewes,
Shoreham,
and Chichester;

and those places now destitute of accommodation should have barracks, stores, and everything requisite necessary for a mixed force provided; and railway carriages kept in sheds, with locomotives ready to move at a moment's notice. And that these essentials should be provided during peace, in which the troops, artillery stores, provisions, and ammunition, could be placed in a few hours, on the probability of a war. This is not involving the country in a vast cost; probably half a million, or 600,000*l.* of money, divided into an expenditure of three years †. It was thought likewise, that these Barrack Stations might advantageously, with a trifling additional expense, be made secure posts of defence against desultory attacks, and be occupied by local troops, in the absence of the regular forces, in the event of an invasion.

M. Maurice, among his several propositions, as alluded to before, gives an unreasonable length of time for collecting our scattered forces, but we apprehend it is not material what the period may be, if they are distant; and hence it is that we urge the importance of having military stations near the coast, ready prepared to receive our troops at the moment of danger; and thus assembled, would be soon organized, brigaded, and practised in moving to the shore by the railway waggons provided for them; very essential, likewise, in respect to training, especially the horses, for this mode of conveyance.

---

* It is certain that the debarkation must take place in boats after the fleet had anchored, taking the troops from the vessels, which never can venture to run on shore and then land them. This is an operation of time quite long enough to enable our troops to meet the enemy.

† This is assuming that the existing defences would be armed and equipped, and that the entrances to the small navigable rivers on the sea coast are well protected; for the first consideration with an enemy would be to obtain possession of some small harbour, which these rivers give at their mouths, for the purpose of landing their stores, artillery, and cavalry.

The second proposition, supposing that an enemy had effected a landing, and secured himself on shore, was the consideration of a parallel line of defence, by the construction of three fortified places between London and the sea coasts; and, under the support of these works, to defend the approaches to the capital, and dispute any available advantageous piece of ground, so as never to allow the enemy to move, except in great force; and by these means render the advance an operation of ten days, which otherwise, without the defences alluded to, could be accomplished in three days.

It was thought that ground might be strongly entrenched, so as to afford a Place of Arms: First; near Tunbridge Wells, to command the communications from the coasts between Dungeness and Beachy Head, and support any defensive operations in the difficult country of the weald of Kent and Sussex. Secondly, at a spot near Balcombe, to command the communications to London from the coasts between Beachy Head and the mouth of the Arun River, and support likewise defensive operations between it and the point of embarkation. The nature of the country greatly favours the advance of an enemy, being open, with many roads concentrating on the capital. This Place of Arms should be considerable, and well secured, as its position would greatly influence the advance of an enemy. Thirdly, a position on the banks of the Arun River, about fifteen miles from its mouth.

What the nature of the defences of these three fortified places should be, it is unnecessary to discuss, but they should be strong enough to resist a *coup de main*, and require heavy artillery to reduce them, that is, involving a siege operation; the aggregate cost would be about 600,000*l*. Contemplating, then, that they were established, armed, and equipped, and those near the coasts were completed, we will resume the supposition of the enemy being on shore, secured and ready to move forward, which would be the mode of defence best to adopt until we had such an army collected and organized in force to meet him advantageously on the field of battle?

It would seem to be that we should form those troops that were too late, or unable to repulse the enemy, into three divisions; giving three-fifths for disputing the advance to London, one-fifth to hang on the enemy's flank to the eastward, retreating, if pressed, on its supports, keeping up its railway communications as long as possible; and one-fifth to act on his flank to the westward, also retreating, if pressed, towards Portsmouth; disputing the passage of the rivers, and prevent him foraging and moving in small bodies; in these flank operations they would be assisted by any local, irregular, or partizan corps, which should occupy the roads diverging from the coast between the railway lines, on which the regular troops are acting.

An enemy thus placed between these columns, which would be increasing in strength every hour, can only advance on London by separating his force, however large, into four parts; one to secure his position on the sea shore, two to secure his flanks, and the major part to move on London. It has been assumed, in the Ninth Volume of "Professional Papers," that the attempt could not be made with less than 100,000 men; we conceive, therefore, this must be diminished to 80,000, in order to preserve his starting-points and flanks; with this force, 80,000, the enemy would probably move in three columns on different roads, sufficiently near for mutual support. This operation, necessarily slow, in order to clear the front of opposing forces, would not exceed ten miles a day, and in fact would be an advance in order of battle. The third day he would be obliged again to detach largely to secure his flanks, by investing the fortified places right and left. This would reduce his forces to 65,000 of all arms. The fourth day, it may be a question whether, with this diminished army, he might not be obliged to fight a pitched battle in some advantageous position * prepared for it. This the enemy may chose to avoid, by turning the position and pushing on to London.

Quoting a question, considered hypothetical, in the Ninth Volume, "It is proposed to imagine a system of defence capable of meeting such a contingency (the near approach to London): the position which it is conceived would form an advantageous line to cover it extends from Woolwich to Windsor, about thirty miles," the points to be fortified being

Woolwich,
New Croydon,
Kingston-on-Thames,
Windsor.

This forms the third and last line of defence deemed capable of being taken up between London and the coast; and supposing, again, that the above points were occupied in strength, and our whole disposable force collected, with the exception of the moveable columns acting on the flanks of the army and the garrisons, it would be impossible to pass between these points; we may then prepare the ground for an advantageous field of battle, and the matter would be brought to a close by a general action.

It may be asked, why diminish our effective army by garrisons and detachments? To this it may be observed, that at the commencement of war a very large portion will be unfit to take the field and meet an enemy in battle; but it could be well employed in garrisons, and brought gradually into an effective state, by acting on the flanks of the enemy. At the commencement of hostilities it would be difficult to collect more than 50,000 effective regular troops to meet an enemy in the field, and then only after diminishing our garrisons of the regular force in every part of the kingdom, and supplying their places with new levies. To this force would be required 50,000 of the army in reserve, or that raised in the emergency of the moment, and probably only clothed, armed and supplied with experienced officers, and non-commissioned officers; and another 50,000 of local or volunteer and partizan corps, would be required on the spur of the danger. These 150,000 comprising

The army of reserve,
The effective army,
Sedentary irregular corps.

" The foregoing observations on the defences of the south coast of England, which the work of M. Maurice has occasioned, will probably interest few beyond the military profession; yet there is no doubt of the fact, that the United Services in France take an interest in the speculation, without any particular ill-will to this country. Therefore, as a mere question of attack, hypothetically considered by M. Maurice, it is met by a counter proposition of defence, as explained above.

But there are several ways of viewing the speculations of conquest, fostered by the army and navy of France: *to leave things to chance, to the probable supre-*

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* Probably near Reigate, so as to secure the lateral branches of the railways, leading to Tunbridge and Dover on one side, and Guilford and Reading on the other.

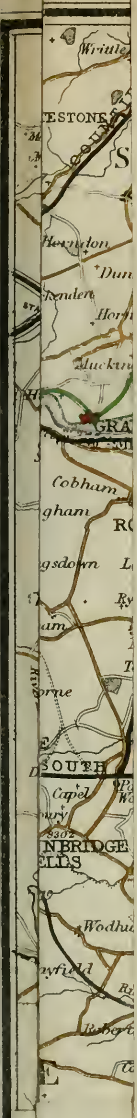
Writtle
ESTONE
S
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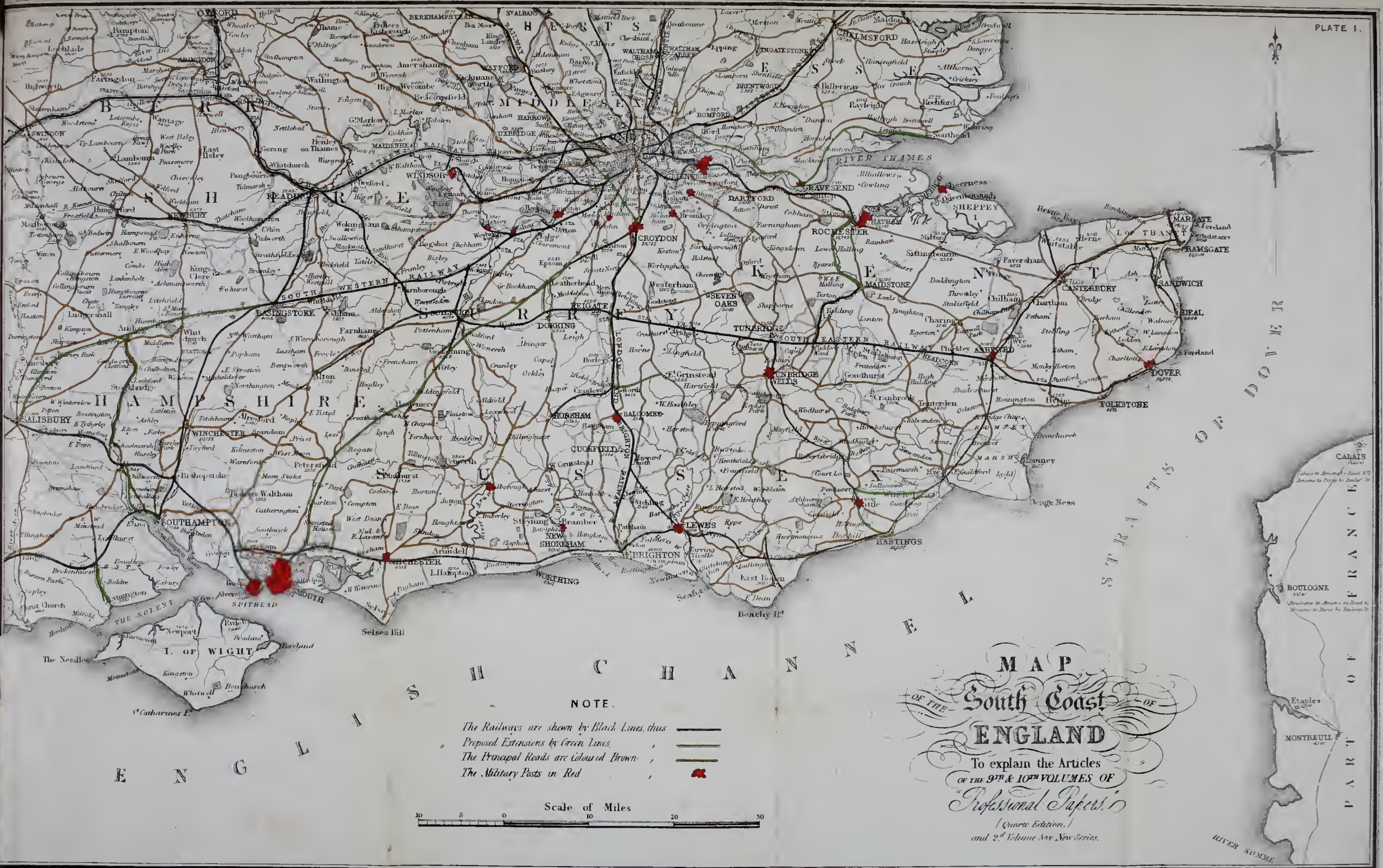
PLATE I.



MAP OF THE SOUTH COAST OF ENGLAND

To explain the Articles of the 9^th & 10^th Volumes of "Professional Papers,"
(Quarto Edition.)
and 2^d Volume New Series.

NOTE.

The Railways are shewn by Black Lines, thus	▬
Proposed Extensions by Green Lines,	▬
The Principal Roads are Coloured Brown,	▬
The Military Posts in Red	●

Scale of Miles

10 5 0 10 20 30

London John Weale, Architectural Library, 59 High Holborn.

[illegible] Lithographer [illegible]

macy of the British navy, or to the possibility, in the event of war, that the French will have other occupations. To these we must, for the present, leave the defenceless state of the country.

The attempt to excite the fears of the public, or awaken the serious attention of Government, so as to consent to the organization of an army of reserve of 50,000 men, ready to be called out, armed, officered, and equipped (somewhat upon the principles of the embodied pensioners), or to the construction of works and defences, may be deemed hopeless.

G. G. L.

November, 1851.

PAPER IX.

DESCRIPTION of CONCRETE BLOCKS used in the FORMATION of the BREAKWATER of the HARBOUR of REFUGE, ALDERNEY, CHANNEL ISLANDS, May, 1851. By Captain F. C. HASSARD, R.E.

ALTHOUGH the use of concrete in the shape of blocks for breakwaters, &c., is no novelty, still a description of those used in the island of Alderney, for the construction of the breakwater now in progress, by the Admiralty, may be interesting and instructive, and especially so, as their goodness and durability have been so severely tried in many heavy gales there, and also from their being so well adapted to form an artificial foundation.

These blocks are of different lengths, from 4 feet 6 inches to 7 feet 6 inches, in order to break bond in the construction of the work, and are placed under water by means of the diving helmet, as a foundation to the external and internal walls, as shown in section. (*See* Plate.)

They are made in the following proportions, the materials being measured separately, in a dry state, in proper boxes.

The Portland cement blocks consist of—

2 parts coarse shingle,
2 do. fine,
2 do. sand,
4 spauls of the island sandstone,
1 Portland cement.
—
11

The lime blocks:—

2 parts coarse shingle,
2 do. fine,
1 do. sand,
2 spauls of island stone,
1 part of ground Aberthaw lime.
—
8

They are made in strong frames or boxes (hereafter described), accurately constructed, true, and square.

Two pieces of mannez, or island stone, are introduced for lifting the blocks with lewises (fig. 2). The stones are 2 feet 6 inches minimum length, roughly squared to 12 inches at bottom and 10 inches at top, with a round lewis-hole in the top of each, 5 inches deep and 1¼ inch in diameter. (See fig. 2.)

The materials are well mixed and beaten together with wooden beaters, and incorporated with a due quantity of water, and are thrown into the boxes in a semi-fluid state, well rammed down around the lewis-stones, so as to form, when set, a solid mass.

A superintendent marks and dates each block. The frames are taken off after from two to three days, according to the weather.

The Portland cement blocks are tested by lifting them four days after they are made, and the lime blocks eight days after.

If they do not support their own weight, they are rejected.

None of the cement blocks are allowed to be used in the works in less than two months after making, and the lime in less than four months, if made in summer, and six in the winter.

A block, 6 feet × 3 feet × 3 feet, or 2 cubic yards, weighs as follows:—

	Tons.	Cwts.
Mortar	3	10
Cement	3	14

One mason and six labourers make four blocks per diem, materials being close at hand.

An improved method of lifting the blocks has lately been adopted, as shown in figs. 6 and 7, as the lewis-stones before described were sometimes split in driving in the lewis, which of course destroyed the block. To remedy this, a block of wood, 7 inches in diameter by 6 inches deep, is placed in the same position as the stones, (that is 1 foot 6 inches from the side and ends), and the materials filled in around them, which are allowed to set sufficiently, and the block is then withdrawn. A shoulder is formed by two pieces of stone, and the block completed, previously having a piece of wood, with an iron bolt in it (fig. 9), placed over the hole (fig. 5). Before the block is uncased, the former (fig. 9) is withdrawn, which leaves the space for the insertion of the key (fig. 10), which is inserted and turned round as shown in figs. 6 and 7.

A better method than using the wooden plug is shown in fig. 8, which is two pieces of concrete, moulded previously, which are placed together at the bottom, as shown in the figs. 5, 6, 7, and the material filled around them at once. It has been found most convenient to make these blocks on a block ground; or rather a series of bottoms of cases, as in fig. 1, are laid, with sufficient space to enable a free passage between them. A moveable crane is erected over them, and they are lifted and piled one over the other until required for use.

Block Cases.

The cases are made of 3-inch planking, bolted through with ¾-inch iron bolts between the cross-pieces. The four sides of the case are placed on a bottom (fig. 1), and secured tightly together by four iron bolts, which are tightened as required by iron washers (*vide* figs. 1, 2, 3, 4). The end-pieces are notched into the side-pieces, and are strengthened at those points by a piece of rough timber, as shown in elevation (fig. 3), and are bound on the top with iron, to prevent the wear and tear diminishing the size of the block. They are then filled as before described.

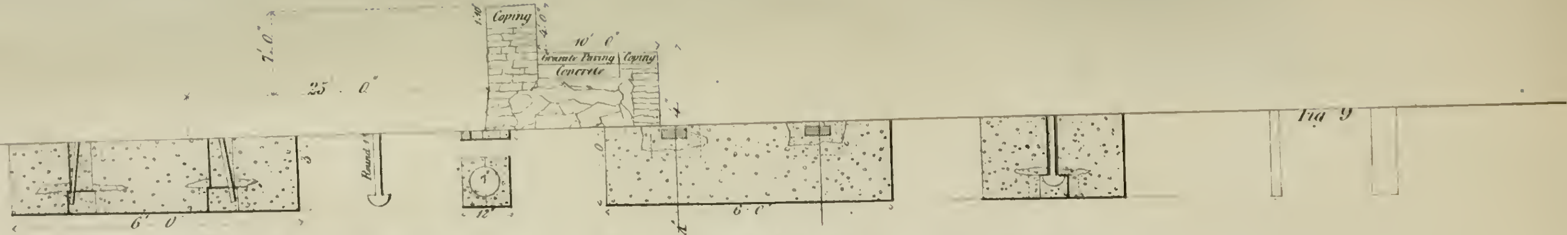
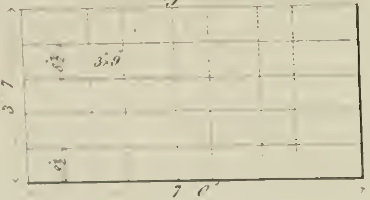
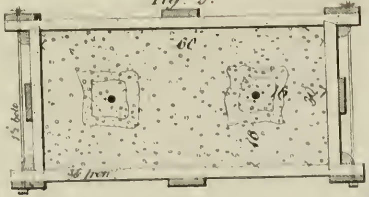


Fig 9

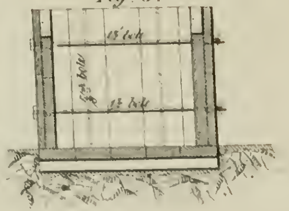
Plan of Bottom of Case.
Fig. 1.



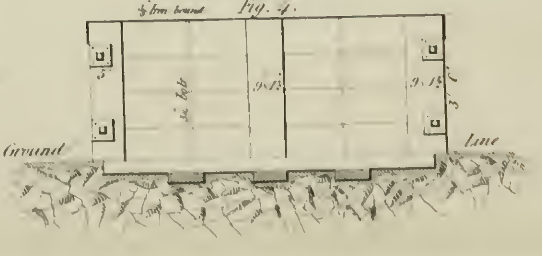
Plan of Case with Block inside.
Fig. 2.



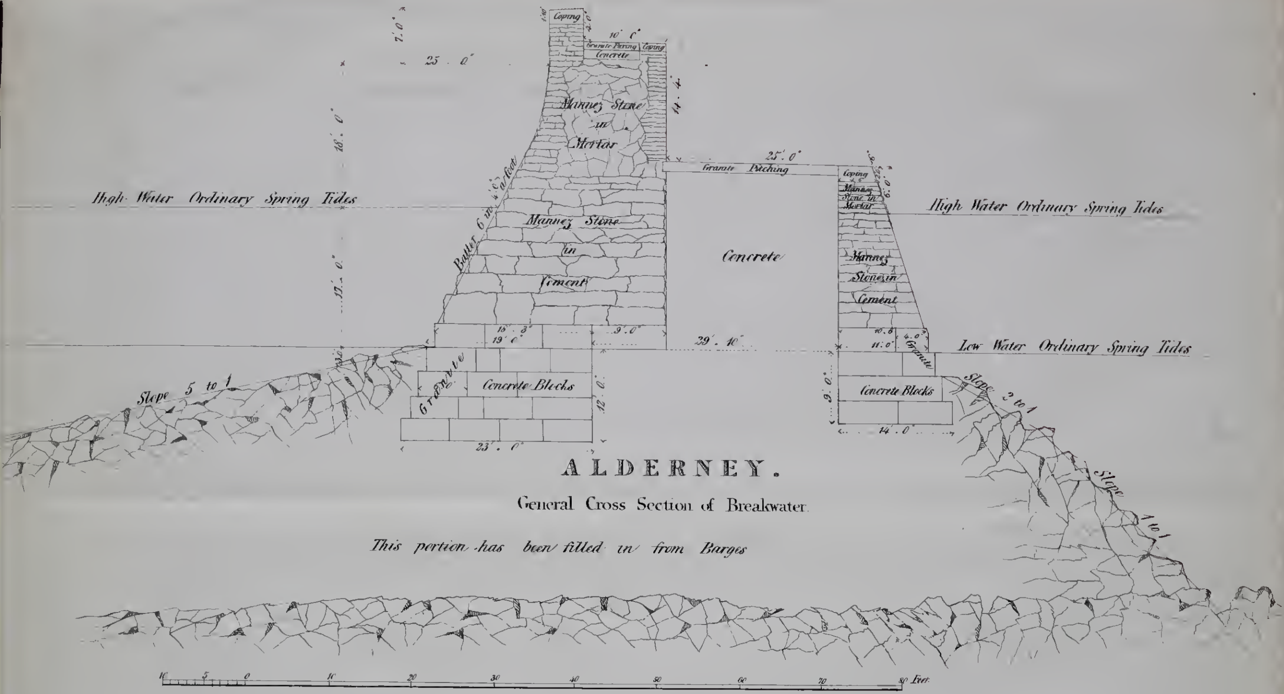
End Elevation
Fig. 3.



Side Elevation
Fig. 4.



Scale, ½ an Inch to a Foot



ALDERNEY.

General Cross Section of Breakwater.

This portion has been filled in from Barges

PLAN &c. OF CONCRETE BLOCKS USED AT BREAKWATER. ALDERNEY.

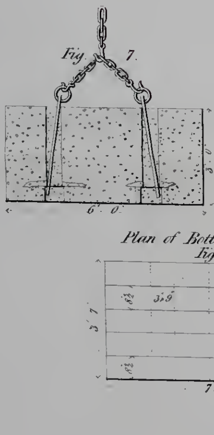


Fig. 7.

Fig 10.

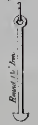
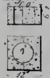
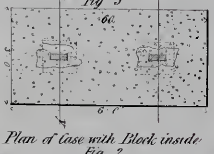


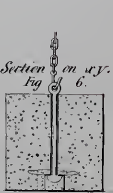
Fig. 8



Plan of Block.
Fig 5



Section on x.y.
Fig 6.



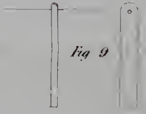
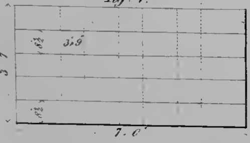
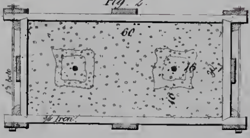


Fig 9

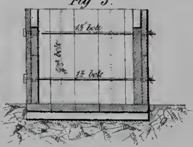
Plan of Bottom of Case.
Fig. 1.



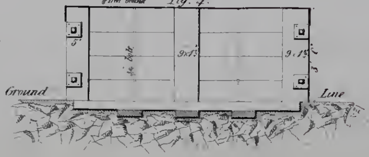
Plan of Case with Block inside
Fig. 2.



End Elevation
Fig 3.



Side Elevation
Fig. 4.



Scale, ½ an Inch to a Foot

The cost of these blocks will of course vary at every place with the price of material; but it may be useful to know that a cement-block of 2 cubic yards will require 5½ bushels of cement, and a lime-block of the same size 6⅛ cwt. of blue lias or Aberthaw lime. These blocks have been found to resist most effectually the action of the sea and weather, and have been thrown off the breakwater without other damage than the edges being slightly chipped where they have come in collision with the rocks and stones.

F. C. HASSARD,
Capt. R.E.

November 15, 1851.

G. Woodfall and Son, Printers, Angel Court, Skinner Street, London.

A CATALOGUE

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3. Section through the centre part of the engine-room, looking forward.

4, 5. Plans, elevations, and sections of the cylinders.
6, 7. Main driving shaft and cranks, details.
8, 9. Section at the fore end of the boilers.
10, 11. Air-pump, connecting-rod, elevation and plan of the parallel motion, air-pumps.
12, 13. Piston, rods, and parallel motion blocks, with plan.
14, 15. Section showing the manner of carrying the cargo deck, and disposition of the plate-sleepers in the ship's bottom, after end.
16, 17. Section at the after end of the vessel, showing sleepers and lower cargo deck.
18, 19. Upper cargo deck, forward, showing the mode of fixing to the sides of the vessel.
20, 21. Plan of the engine and boiler-room, upper deck.
22, 23. Longitudinal section through the engines and boilers.
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APPENDIX A, B.

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Plan, ditto, ditto.
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LIST OF SUBJECTS AND PLATES.

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End views of both engines at the paddle shaft, with a section of the vessel taken at the same point, &c.
Front elevation, section in elevation, and plan of the cylinder, steam nozzles, and slide gear, with details of the eccentric, &c.
Different views of the condensing apparatus, feed and bilge pumps, &c.
Details of the parallel motion, connecting-rod and piston, cross-head, &c.
Elevations of part of one paddle-wheel and shaft, &c.
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Sheer draught, lines of bottom, and after body of the *Orion* Ipswich iron packet.
Plan of deck of ditto.
Longitudinal elevation of one of the engines of the *Isis*.
End elevation of ditto, showing paddles, shaft, and construction of vessel.
Plan of the engines of the *Isis*, together with the boilers, engine-room, &c.
Sheer draught, profile of inboard works, with lines of bottom, and after body, of Her Majesty's steam frigate *Cyclops*.
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4. Do. do.
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8. Transverse section of do.
9. Section of foot-path on do., &c.
10. Occupation bridge over the Calder and Hebble Navigation, by W. Bull.
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12. Do., do.
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28. Longitudinal section of ditto, showing the progress of the works in 1832.
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30. Cross section of Hutcheson bridge.
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